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Paratransit Handbook

a guide to Paratransit System Implementation

Volume I February 1979
Final Report

Prepared by

Systan Inc.
Los Altos, Cal. 94022

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16. Abstract

This Paratransit Handbook has been developed to aid public officials, planners and system operators in planning, designing, implementing, operating and evaluating integrated paratransit systems. The Handbook represents a compedium of techniques and experience drawn from existing dial-a-bus and shared-ride taxi paratransit systems. Five interrelated sections in two volumes comprise the Handbook: Volume I; Part 1, the Introduction, summarizes the current state-of-the-art of integrated paratransit systems; Part 2, Creating the System, contains prescriptive guidance for the individual tasks required in planning, designing, implementing, operating and evaluating integrated systems. Each element of this key section contains overview flow diagrams showing the major relationship of individual tasks, cross-references to more detailed examples contained in other sections of the Handbook, and a summary of pitfalls to be avoided. Part 3, System Characteristics, summarizes the operating characteristics of over 100 dial-a-ride and shared-ride taxi systems, and presents specific guidance regarding target market systems for the elderly and handicapped. Volume II; Part 4, SCRAPS, contains detailed information on Service Components, Regulations, Analytical Procedures, and Sources to complement the planning and design process. Part 5 contains Appendices, including references, a glossary, summaries of individual system characteristics and other technical material.

17. Key Words Paratransit, Dial-A-Bus, Shared-Ride Taxi, Guidelines, Planning, Design, Operations, Implementation, Evaluation, Pitfalls, Operating Characteristics, Target Market Systems, (cont.)	18. Distribution Statement Vehicles, Maintenance, Marketing Models, Labor, Funding, State-of-the-Art, and Future Growth. DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

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PREFACE

The Paratransit Handbook has been developed as a guide to the implementation of paratransit systems. Public officials, planners, and system operators considering paratransit alternatives should find this handbook an aid in the planning, design, implementation, operation, and evaluation of these services.

The Paratransit Handbook was prepared by SYSTAN Inc. of Los Altos, California under contract No. DOT-TSC-1392, and represents the first major step toward a comprehensive planning handbook. It is anticipated that this version of the Handbook will be updated and revised in accord with (1) research results designed to fill information gaps, (2) new paratransit systems experience, and (3) feedback on organization and content from users of this document. For the purposes of initiating feedback a mailable comment sheet has been incorporated at the end of section 3. (See Table of Contents: Comments Please!) Any additional information and comments will be greatly appreciated. Initial updates to the Handbook will be found in the Pocket Parts at the rear of each volume.

Dr. Roy E. Lave of SYSTAN has served as project manager for the current contract, while Dr. John W. Billheimer was the project leader responsible for developing the Handbook. Other SYSTAN participants were Dr. Paul Jones, Ms. Carolyn Fratessa, Mr. Michael Holoszyc, and Ms. Debra Newman. Ms. Catherine Pearsall and Ms. Carole Parker helped to organize and edit the final document. Mr. Paul Bushueff of the Transportation Systems Center acted as technical monitor for the U.S. Department of Transportation.

In addition to the participants listed above, more than 200 members of the paratransit community contributed to this effort by providing system data and insights regarding the problems and pitfalls encountered in planning, implementing, and operating paratransit systems.

NOTE: In draft form this two volume report was entitled "Paratransit Integration Guidelines."

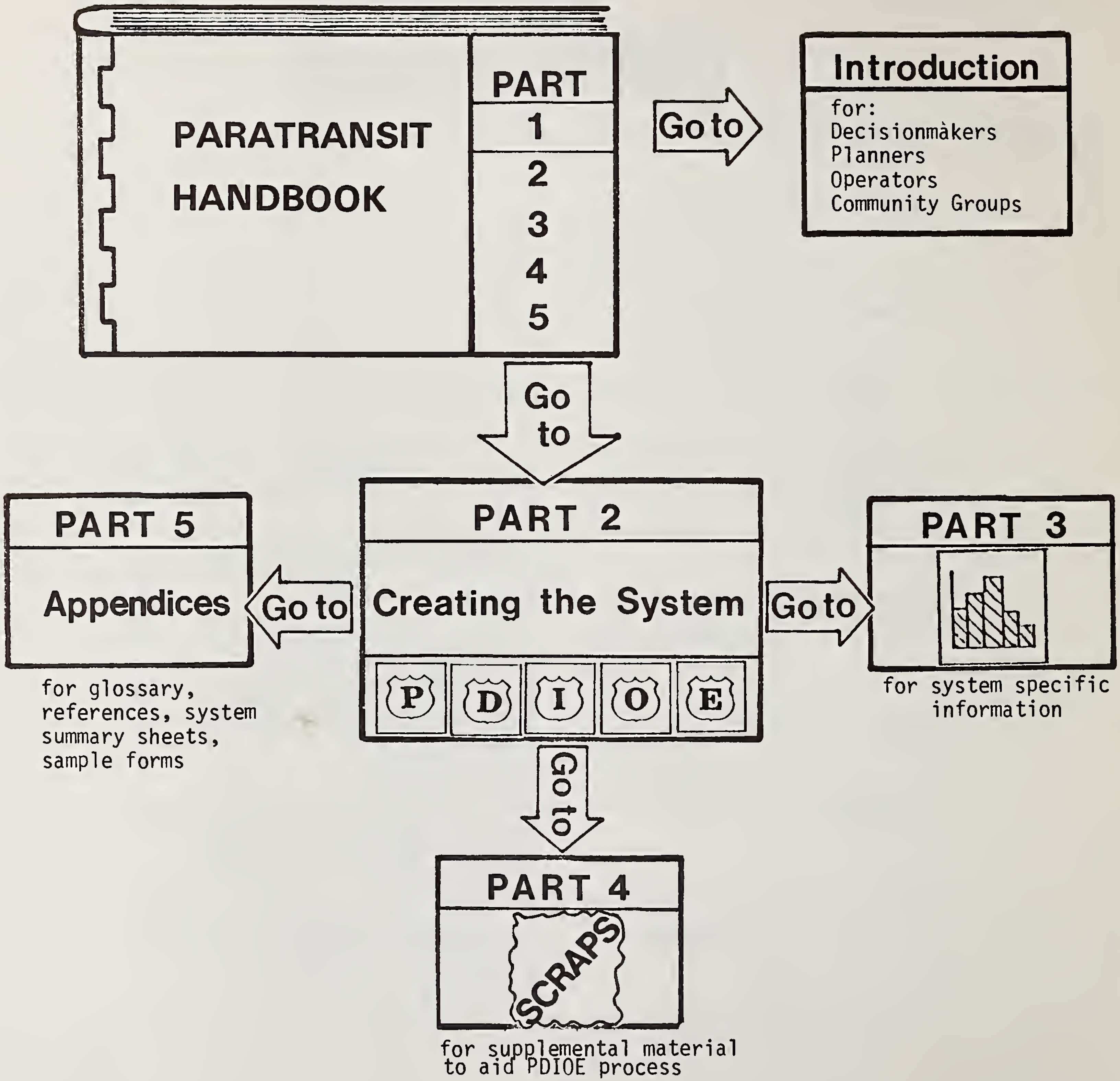
USER'S GUIDE

This Handbook consists of five parts, in two volumes, with blue divider sheets designating each part:

Volume I - 1. Introduction;
2. Creating the System;
3. System Characteristics;
Volume II 4. SCRAPS; and
5. Appendices.

Their contents are summarized below and their relationships illustrated in exhibit at left.

PART	TITLE	CONTENTS
Volume I 1	Introduction	Summary statement of paratransit state-of-the-art
2	Creating the System (PDIOE)	Prescriptive guidance for accomplishing Planning, Design, Implementation, Operations and Evaluation
3	System Characteristics	System-Specific Information
Volume II 4	SCRAPS	Service Components, Regulations, Analytical Procedures, and Sources
5	Appendices	References, glossary, system summaries and technical material

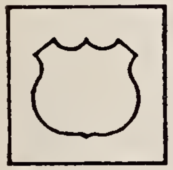

PARATRANSIT
HANDBOOK
PART
1
2
3
4
5
Go to
Introduction
for:
Decisionmakers
Planners
Operators
Community Groups
Go to
PART 2
Creating the System
P
D
I
O
E
Go to
PART 5
Appendices
for glossary, references, system summary sheets, sample forms
Go to
PART 3
for system specific information
Go to
PART 4
SCRAPS
for supplemental material to aid PDIOE process

Volume I

GETTING STARTED - Part 1: The Introduction

The Introduction is intended for a wide audience: decisionmakers, planners, operators and interested community groups. It is designed to be used in several ways:

- An overview of transit trends, the spectrum of services available and the paratransit role which has developed.
- An update on the state-of-the-art in paratransit.
- A decisionmaker's guide to assess whether paratransit is attractive for his/her community and whether to proceed into the sketch planning stage.

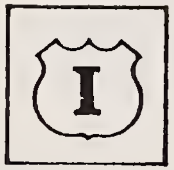


CREATING THE SYSTEM - Part 2

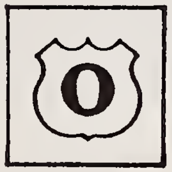
Within Part 2 the five stages of system development: planning, design, implementation, operation and evaluation (PDIOE), are subdivided into sections and divided visually by a shield symbol in the upper page corner as noted below. This scheme allows easy access to different sections of system development stages.

Planning
Section 2

Design
Section 3



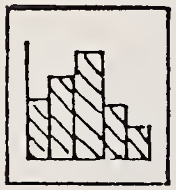
Implementation
Section 4



Operation
Section 5

Evaluation
Section 6

Each section begins with an Overview, followed by Procedures, and ends with a review of Pitfalls to be avoided.



WHAT EXISTING SYSTEMS ARE LIKE - Part 3: System Characteristics

Part 3 on System Characteristics is divided into four sections: 1 - Introduction, 2 - Measurements of System Characteristics and System Performance, 3 - General Market Systems, and 4 - Target Market Systems. These last two sections each cover two generic types of systems: dial-a-bus and shared-ride taxi and are symbolized as follows:

General Market

Dial-A-Bus

Shared-Ride
Taxi

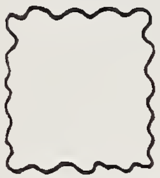
Tarket Market

Dial-A-Bus

Shared-Ride Taxi

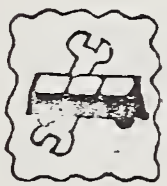
Operational data from existing systems are summarized for each of the categories listed above, and characteristics and system profiles are developed. In addition, any system development considerations which are unique to target market service are discussed within Section 4.

Volume II

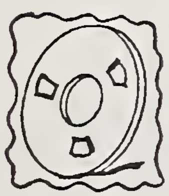


SCRAPS - Part 4

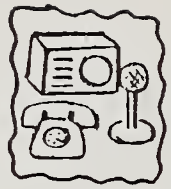
SCRAPS, identified by a ragged-edged symbol, consists of the 8 sections listed below and contains detailed information which is supplemental to the PDIOE process.



Vehicles and Maintenance

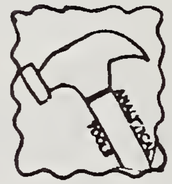


Computerization of DRT Systems



Communication Systems and Equipment

Marketing and Customer Information



Analytical Procedures and Tools

Labor

Funding

Future Growth of Paratransit

AT THE BACK - Part 5: Appendices

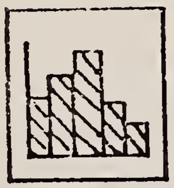
The Appendix material consists of references; a glossary of terms; a system inventory and system summary sheets; alternative paratransit systems; detailed model attributes; Federal policies; forms and surveys used in existing system development; and future paratransit plans.

WORKING BACK AND FORTH

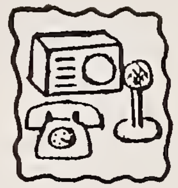
Those parts of the Handbook which follow Part 2, Creating the System, are intended as reference material to fill in specific information needs which may arise while working through different stages of system development. They may also be used independently as a source of state-of-the-art material on specific subject matter; e.g., statistical profiles of existing systems (Part 3: System Characteristics), computerization (Part 2: SCRAPS), sample operating forms (Part 5: Appendix).

To facilitate the use of these sections, symbols are sprinkled throughout the Handbook, particularly within Part 2 Creating the System, indicating to the reader where more detailed information is available if needed. For example:

2.2.5 refers the reader to a specific subsection (2.2.5) within Planning, in Part 2: Creating the System.



4.1 refers the reader to Operational Data Section 4.1 on Target Market systems in Part 3: System Characteristics



refers the reader to communication systems in Part 4: SCRAPS

refers the reader to Appendix 4, System Summary Sheets in Part 5: Appendices

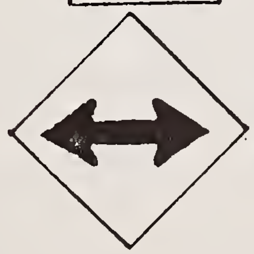
THE HIGHLIGHTERS

One group of symbols appear within the text to highlight recurring items or help locate particular types of information:

The Pitfall occurs throught the PDIOE process and elsewhere when necessary.

The Checklist occurs whenever material can be conveniently arranged for ready reference.

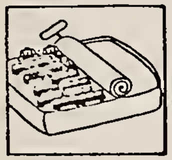
The Checkpoint means stop and review the situation.



The Decisionpoint indicates that action is required before proceeding to the next stop.

TABLE of CONTENTS

VOLUME I - PARTS 1 - 3



PART 1: INTRODUCTION

SECTION:

PART 2: CREATING THE SYSTEM

PART 3: SYSTEM CHARACTERISTICS

VOLUME II - PARTS 4 & 5

PART 4: SCRAPS

PART 5: APPENDICES

PART 1

1.0 OBJECTIVE AND SCOPE OF HANDBOOK

1.1 Objective

The major objective of the Paratransit Handbook is to provide a set of tools to be used in assessing the utility of shared-ride paratransit systems and in planning, designing, implementing, operating, and evaluating such systems. These systems range from simple shared-taxi service arrangements in small cities to computer-assisted dial-a-bus systems with large service areas. A five-phase system development process has been defined based on the experience of existing systems. These five closely-related development stages are: (1) Planning; (2) Design; (3) Implementation; (4) Operations; and (5) Evaluation. Each of these stages is addressed in a handbook section entitled "Creating the System," which is augmented with appropriate checklists and a list of pitfalls encountered by past system developers. Other sections of the handbook summarize the characteristics of existing systems, discuss the state-of-the-art of service components, regulations, analytic procedures, and itemize source materials.

Communities may be at different stages in their discussions of paratransit, and the handbook is intended to provide information directed at various stages of development. The handbook should be useful for those who want to:

- o Gain an understanding of the paratransit concept;
- o Assess the potential applicability of paratransit in a specific region;

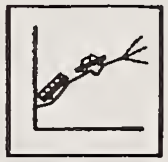
INTRODUCTION

- o Plan a system from the beginning;
- o Change or modify an existing system; or
- o Integrate a paratransit system with fixed-route transit.

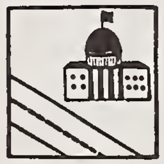
SECTIONS OF THE INTRODUCTION

1. Objective and Scope of the Handbook

5. What Existing Paratransit Systems are Like



2. Trends in Travel and Paratransit Usage



6. Off-the-Road Issues

3. What Paratransit Is

7. The Growth of Paratransit

4. What Paratransit Does

1.2
1.3

1.2 Scope

The handbook focuses on integrated paratransit systems having the following characteristics. They

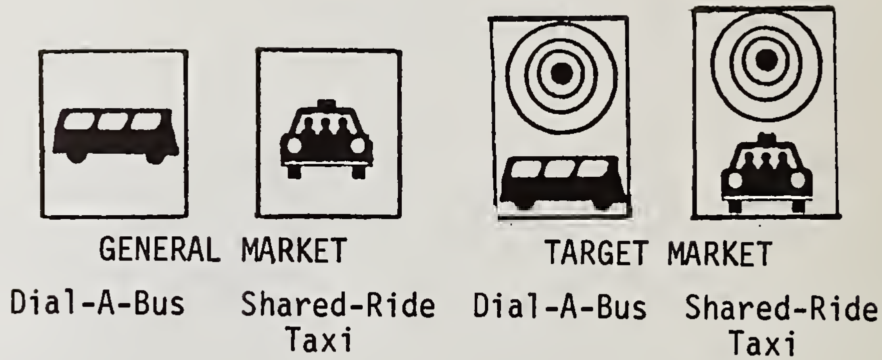
- Are demand-responsive;
- Use coordinated vehicle dispatching;
- Offer shared-ride service;
- Employ paid professional drivers;
- Are available to the public;
- Operate on street networks; and
- Follow flexible rather than fixed routes.

The most common examples of systems having these characteristics are shared-ride taxis and dial-a-bus services. The characteristics of other paratransit services (e.g., subscription bus, vanpool) are considered in the planning stage as service options and during the screening of transit alternatives. The integration of shared-ride taxi and dial-a-bus with fixed-route systems (e.g., fixed-route bus and rail) is addressed in the five-phase development process.

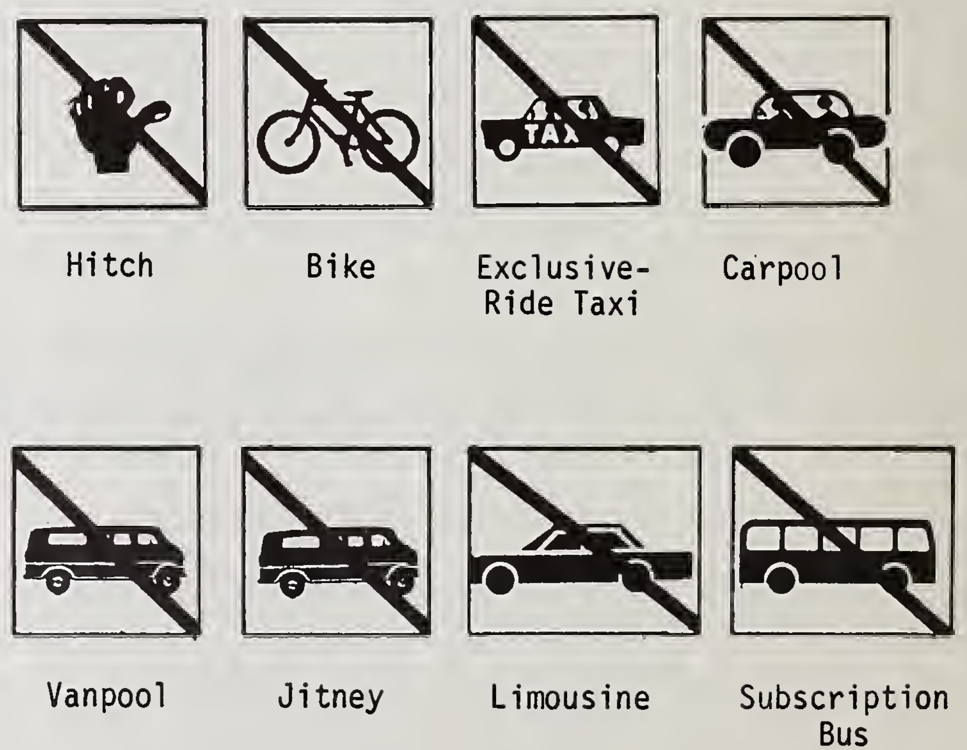
1.3 Audience

While the main users of the guidelines will be planners--particularly at the local level--the guidelines are also intended for policymakers and decisionmakers, public and private transportation operators, and interested members of the community. It is the intent of the guidelines that both those professionals within the transportation business and those outside of it find information and guidance to make informed decisions about the provision of paratransit service.

SERVICES CONSIDERED



SERVICES NOT CONSIDERED



2.0 TRENDS IN TRAVEL AND PARATRANSIT USAGE

2.1. Historical Perspective

Prior to 1912, railroads and electric streetcars carried almost all urban passenger traffic. The challenge to rail transit began on that day in 1908 when the first Model T rolled off a Michigan assembly line. Henry Ford's mass production techniques not only brought the automobile within the grasp of the private buyer, but also revolutionized the face of public transportation. Buses operating on fixed routes began competing directly with streetcars and railroads. In addition, more personalized service was provided by a variety of more flexible modes, including taxis, jitneys, charter services, rental automobiles, subscription buses, dial-a-ride services, and carpools. These and other personalized transportation services have recently come to be called paratransit services, defined as:

> "...those forms of intraurban passenger transportation which are available to the public, and distinct from conventional transit (scheduled bus and rail) and can operate over the highway and transit system." (Reference 1)

Both automobile and bus travel grew steadily from their inception, until the mid-1940's when transit patronage declined sharply. At the same time, the years following World War II saw a marked increase in personal automobile use. Today, the automobile stands unchallenged as the chief means of transportation in U.S. cities and is the standard by which transit services are judged. Several factors have brought the automobile to this preeminent position, including its convenience, the existence of an extensive road network, the availability of relatively inexpensive fuel, and an ownership cost which has been within the budget of most U.S. households.

(Source: California Historical Society)

2.1
2.2

As the automobile has come to dominate conventional transit modes, paratransit modes have undergone a variety of metamorphoses. The taxi, the oldest and most common form of paratransit, has enjoyed steady popularity. In the U.S. today, taxis earn more revenue than all other forms of public transit combined, and carry more passengers than rail transit and one-half as many as bus transit (References 11 and 92).

For a brief period in transit history, a form of shared-ride, fixed-route taxi--the jitney--was a popular and successful form of paratransit. In 1914, driver-owned Model T's plied the streetcar routes in Los Angeles, picking up passengers for a nickel fare. Within a short time, the concept spread across the country. It has been estimated that, by 1915, sixty-two thousand jitneys were in operation throughout the U.S. (Reference 99).

Jitneys vied successfully with the streetcar, no doubt due to the faster, more comfortable service they provided. Their success, however, was their undoing. Competitors lobbied and won legislation that so repressed jitney operations that, by the end of 1918, only an estimated six thousand jitneys were running. By 1920, they had virtually disappeared from the transit scene. Legal jitneys operate today in only a few U.S. cities: San Francisco, Pittsburgh, Miami, Atlantic City and Anaheim (Reference 1). However, illegal jitney operations exist in several U.S. cities.

The jitney service is still a viable system in a number of countries, many of them in less developed areas including Caracas, Mexico City, Buenos Aires, Puerto Rico, Istanbul, and Manila (Reference 1).

2.2 Changing Travel Patterns

Significant changes in urban travel patterns have accompanied the rise of the automobile to its position of preeminence in urban transportation. Americans traveling from here to there within the urban region have greatly increased the number of "heres" and "theres" desirable as origins and destinations, thereby causing travel patterns to become increasingly diffuse and decreasing the relative importance of the central business district (CBD).

Although the growth of automobile usage has accompanied the growth of the suburbs, neither the automobile nor conventional fixed-route transit is well suited to serving the diffuse travel patterns emerging from the growing tendency of U.S. cities toward suburbanization. Whereas automobiles offer convenience and accessibility in the low-density suburbs, their land-hungry nature makes them ill-suited for service in high-density central business districts. Conventional fixed-route transit systems capable of providing such districts with congestion-free service, however, cannot economically serve the low-density suburbs. An effective regionwide public transportation system appears to require a mixture of complementary systems capable of acting cooperatively to respond to the diverse travel patterns found in the urban area. Such a mixture might include flexibly-routed, demand-responsive feeder systems in the low-density suburbs, with fixed-route express bus or rail service linking activity centers and high-density circulation systems providing access within major activity centers.

Recognition of the need for an integrated mixture of flexibly-routed and conventional transit modes capable of responding to changing travel patterns has spurred a revival of interest in paratransit services. Over the last decade, the number of paratransit systems in operation has increased annually. In 1974, the results of experimentation, research, and operating experience were compiled and published in a major work entitled Paratransit: Neglected Options for Urban Mobility (Reference 1). The family of demand-responsive services was given the name of "paratransit," and was arranged in three classes: hire-and-drive services, hail or phone services, and prearranged ride-sharing services. The recent history of paratransit and its growth in the 1970's is shown in the exhibit on the next page.

HISTORY OF SIGNIFICANT PARATRANSIT DEVELOPMENTS

1962 - Dr. Josef Kates and Neal Irwin of Traffic Research Corp. proposed a system of small, user-activated vehicles as a feeder to the Washington, D.C. subway.

- Peter Zaphyr of Westinghouse Electric submitted a patent disclosure on a computerized-demand bus system.

- John Crain of Operations Research, Inc., involved in the Washington study with Kates et al., outlined his taxibus concept (Ref. 17)

1964 - John Crain, Paul Jones and John Billheimer tested taxibus without passengers but with one vehicle and one dispatcher at the Stanford Research Inst., Menlo Park, CA.

- The Metran project in the Systems Engineering Dept. of MIT proposed DAB, called "GENIE," as one of several transit ideas. (Ref. 18)

- Michael Blurton of the Univ. of Illinois experimented with the "Premium Special" subscription bus in Peoria and Decatur, Ill., sponsored by HUD. This project demonstrated the enthusiastic response to a high-quality bus service.

1965 - Prof. Daniel Roos and N.H.M. Wilson of MIT launched "Project CARS," which provided the most thorough work on computer-aided routing of DAB systems. (Ref. 185, 186)

1967 - Westinghouse Air Brake Co. conducted a study for HUD recommending Demand-Actuated Road Transit (DART). (Ref. 179)

- Graduate students in the Civil Engineering Dept. of Northwestern Univ. worked on a small-scale simulation of a many-to-many system. (Ref. 81)

- E. Archer and Prof. John Shortreed of the Univ. of Waterloo worked on a DAB demand model for Kitchener-Waterloo, Ontario. (Ref. 158)

1968 - The General Motors Transportation Research Dept. conducted the "New Systems Implementation Study" for HUD, and conducted that DAB was one of the most promising solutions to future transportation needs. (Ref. 16)

1969 - General Motors conducted the Demand-Responsive Jitney (D-J) Systems Study to investigate all variables or users' attitudes which might affect the system and to evolve a comprehensive system design.

- The first route diversion DAB system began in Mansfield, Ohio directed by Karl W. Guenther of Ford Motor Co.

- A subscription service sponsored by HUD was operated in Flint, Mich. without success, due to employment characteristics and excessive routes.

1970 - GO-Transit inaugurated the first many-to-one service to the Pickering Station for Bay Ridges, Ontario. Off-peak, many-to-many service was provided locally.

- DRUBS was initiated at Kent State Univ. by Michael Blurton. This was a demand-routed bus service to and from the Univ. using specially-designed electronic aids.

- The Buxi system, installed in Emmen, Holland, offered many-to-few service.

1971 - Columbia, Maryland initiated a many-to-many DAB service.

- W.A. Atkinson operated the Telebus service in Regina, Saskatchewan, sponsored by the Federal, Provincial and Municipal Governments.

- Many-to-few DAR service began in Ann Arbor, Mich., operated by the Ann Arbor Transit Auth. with technical input from the Ford Motor Company.

- The Ecole Polytechnique de Montreal and the Transportation Development Agency of Canada commenced work on a DAB Implementation Manual.

- The DAB service in Columbus, Ohio began as a modified many-to-many system; it was planned by the Ford Motor Company.

- Batavia Bus Service operated a many-to-many and many-to-few DAB by manual dispatching. Batavia was the first community to replace fixed-route transit with DRT.

1972 - The Haddonfield DAR experiment, jointly sponsored by UMTA and the NJ DOT, began, providing many-to-one service to the Lindonwold RT line as well as many-to-many service within Haddonfield. The MITRE Corp. evaluated the demonstration, the first system in which computer routing was tested.

- John Lawson of Fort Walton Beach, Florida, operated the first private Call-A-Ride service providing many-to-few service to shopping centers, schools, golf courses, and certain intersections.

- Kingston, Ontario implemented a local evening DAB service.

- Stratford, Ontario implemented a citywide evening DAB service, with planning conducted by Reed, Voorhees and Associates.

- A many-to-few service began in Maidstone, Britain by the Denis Hire Car Co. Service was to the railway station and the town center.

- At least 11 other DRT systems were initiated in the U.S. (Ref. 260)

1973 - DAB service integrated with fixed-route service began in Rochester. The computer-controlled system began in 1976.

- At least 24 other DRT services were initiated in the U.S. (Ref. 260)

1974 - Michigan implemented a program of local funding to initiate DRT service.

- Santa Clara County began to operate a computer-controlled, integrated demand-responsive/fixed-route transit system; it was terminated in 1975.

- At least 40 other DRT systems were initiated in the U.S. (Ref. 260)

1975 - At least 50 DRT systems were initiated in the U.S. (Ref. 260)

1976 - At least 38 DRT systems were initiated in the U.S. (Ref. 260)

1977 - At least 21 DRT systems were initiated in the U.S. (Ref. 260)

* Essentially all of the material from 1967 to 1972 is reproduced from the Canadian Dial-A-Bus Manual, Volume II (Reference 4).

3.0 WHAT PARATRANSIT IS

3.1 Range of Paratransit Services

The term "paratransit" covers a wide variety of systems, ranging from rent-a-car operations to carpooling and from exclusive-ride taxis to shared-ride subscription services. The glossary (Appendix 2) provides commonly-accepted definitions of the existing paratransit services, which also include jitneys, charter limousines, dial-a-ride systems and shared-ride taxis. The distinction between these separate services is not always clear-cut, as a specific system may incorporate the characteristics of more than one of the paratransit family members. For example, a single hybrid system may adopt some aspects of a dial-a-ride, jitney and subscription service.

3.2 A Paratransit Classification System

In addition to combining the aspects of different forms of service, paratransit systems may differ with respect to: the degree of coordination provided by the dispatching system, trip-sharing requirements, markets served, method of accession, route and schedule constraints, pick-up locations, institutional arrangements governing the service, etc. The accompanying exhibit classifies paratransit systems according to the major characteristics which define the options available to system designers. In choosing from among these options, designers may select any combination of characteristics to generate a family of services adapted to the perceived needs of their communities. The inherent flexibility of paratransit defies the neat categories of any single classification system, including the one shown in the exhibit. Nonetheless, some attempt to trace the major branches of the tangled paratransit tree is necessary to define the boundaries of this handbook.
The following subsections describe the major characteristics of paratransit systems in detail. The reader familiar with these characteristics is referred to the next section (3.3), which defines the scope of the current review in terms of the taxonomy displayed in the exhibit.

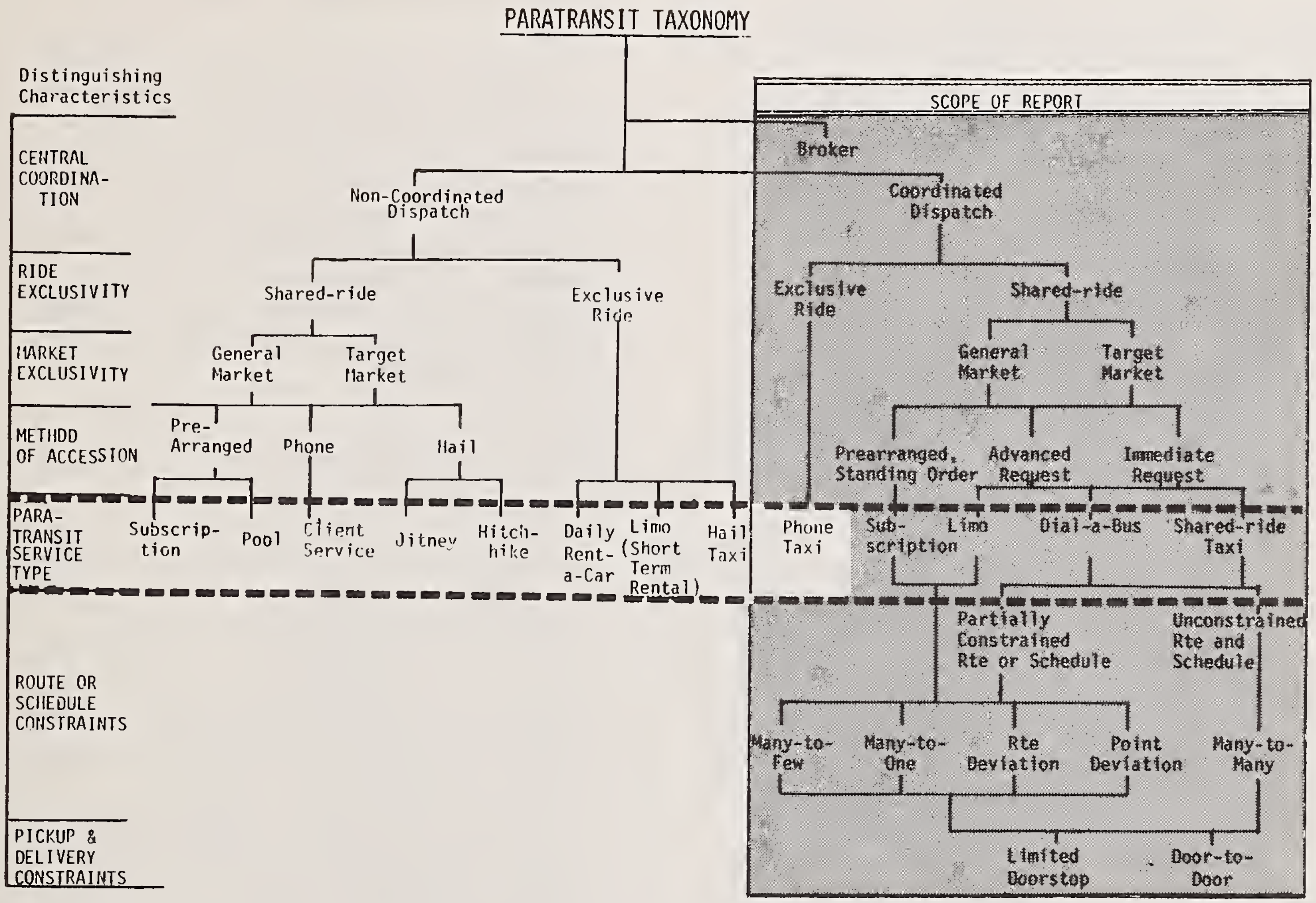
3.2.1 Coordinated Versus Non-Coordinated Dispatching

At the top of the classification tree are two main branches of paratransit systems: those having a coordinated dispatching system and those capable of operating without coordinated dispatching. The coordinated dispatching system is characterized by a centralized process that assigns passengers to vehicles using procedures intended to balance cost-efficiency and timely service. The exhibit on the following page illustrates the generic procedure in which service is requested and vehicles are dispatched. Users generally phone in to arrange for such services, although some centrally-coordinated systems occasionally will respond to random hails or pick up passengers at designated stops.

In non-coordinated services, vehicles generally operate independently, and are contacted directly by the user. There is little or no need to coordinate vehicle movements. This class includes hail- and phone-access services, hire-and-drive services, pooling arrangements (car, van and bus), and pre-arranged subscription services which schedule more than one trip over a period of days or weeks. Many of the services provided by social service agencies are usually included in this classification, as they tend to be pre-arranged or ad hoc responses requiring no vehicle coordination or they lack an on-going dispatching function.

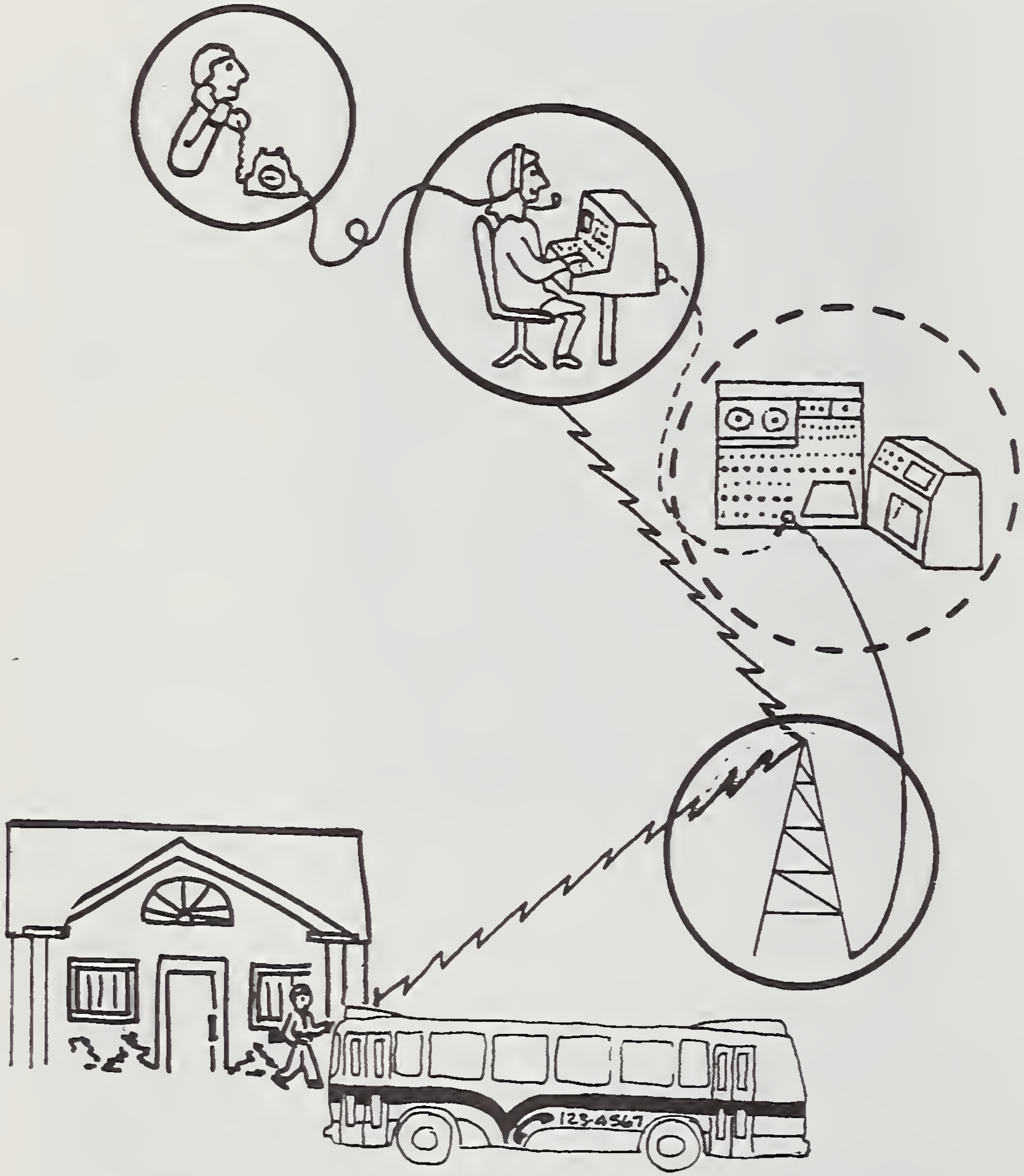
3.2.2 Exclusive-Ride Versus Shared-Ride

The next division in the paratransit taxonomy separates shared-ride services from systems supplying exclusive service. Exclusive taxi service usually serves only one person or a small group of individuals traveling together, and may be accessed either by telephoning or by hailing. Vehicle rental agencies also offer exclusive service. This report focuses on shared-ride services, and excludes all exclusive-ride services.



(Source: SYSTAN)

SERVICE REQUEST AND VEHICLE DISPATCH PROCEDURE



3.2.3 General Market Versus Target Market

Services may be further divided by the type of market they serve. General-market services are those available to any potential user within the service area. Target-market systems, in contrast, are designed for specific markets, and usage is restricted to persons meeting certain eligibility requirements. Typically, these are services for the elderly, handicapped, persons of low income, school children, or any combination of these users. In other cases, systems may be designed to serve certain types of trips, such as the journey to work or shopping trips.

3.2.4 Advance Request Versus Immediate Request

Rides for either general or target market service may be accessed by advance arrangement or by requesting immediate service. Advance request service accepts orders for pick-up at a specified time later in the day or for a subsequent day. These orders may be standing requests for daily or weekly service, renewed by the week or by the month, or they may be one-time-only requests for service. Advance-request service, commonly called subscription service, may operate without coordinated dispatching or may be physically-integrated with other coordinated dispatch services in order to share vehicles and drivers. Therefore, subscription service appears on both the non-coordinated and coordinated branches of the classification tree.

Immediate-request service provides pick-ups as soon as the request can be scheduled, in the manner of exclusive-ride taxis. Some systems accept only advance requests (requiring several hours notice), while others will accept both advance and immediate requests.

3.2.5 Dial-A-Bus Versus Shared-Ride Taxi and Limousine Service

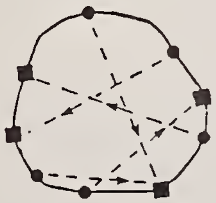
Both immediate- and advance-request services may be offered in one of three modes, which differ primarily by the type of vehicle employed. Dial-a-bus (DAB) service is provided by small buses or vans; limousine service uses large luxury automobiles; and shared-ride taxi service employs taxi vehicles, which are essentially passenger cars. The services differ also by the type of operator. Shared-ride taxi service is generally offered by private taxi operators; limousine service is usually provided by private operators who may also be taxi operators; while DAB vehicles are operated by private or public organizations. However, taxi operators could theoretically offer DAB services, and public operators could use automobiles for dial-a-ride service, so the classifications are not mutually exclusive.

3.2.6 Unconstrained Versus Partially-Constrained Routes and Schedules

Any of the coordinated-dispatch services may be offered through a variety of routes and schedule patterns, as described below.

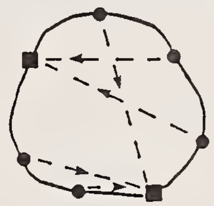
(A) Unconstrained Route and Schedule

<u>(i) Many-to-Many</u>: Demand-responsive transit service that serves any origin, such as a home, and any destination within a service area.

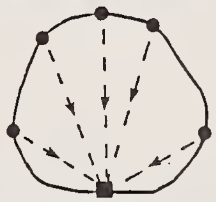


(B) Partially-Constrained Route and Schedule

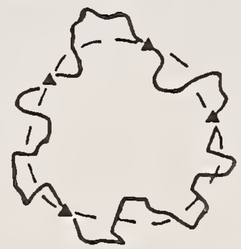
<u>(i) Many-to-Few</u>: Demand-responsive transit that serves any origin, such as a home, and a few pre-selected destinations, typically activity centers or transfer points.

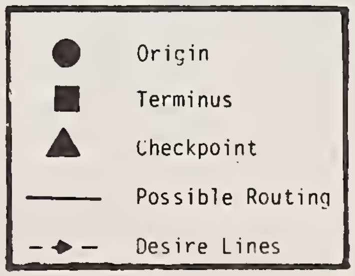


<u>(ii) Many-to-One</u>: Demand-responsive transit that serves many origins, such as homes, and only one destination, such as a shopping center or a commuter rail station (also called gather-and-scatter service).

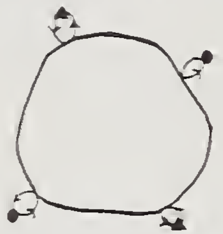


<u>(iii) Deviation From Point</u>: A demand-responsive transit service which makes regularly-scheduled stops at designated points but is free to provide door-to-door service between checkpoints.





(iv) <u>Deviation From Route</u>: A demand-responsive transit service pattern in which a normally fixed-route bus leaves the route upon request to serve patrons not on the fixed route.



Schedule and route constraints may vary by time of day within a single system. For example, subscription service may be offered during peak operating hours, while many-to-many requests may be honored during the off-peak period. Subscription service is usually offered as a many-to-few service, while airport limousines are an example of a many-to-one service.

3.2.7 Door-to-Door Versus Limited-Doorstop Service

Any of the above route schedule options may be offered as a door-to-door or limited-doorstop service, as defined below:

- Door-to-Door Service. Demand-responsive transit providing service from any point of origin to any point of destination (doorstop to doorstop).
- Limited-Doorstop Service. Demand-responsive transit providing service from selected points of origin and destination, requiring users to walk to the selected points. The procedure may be used in many-to-many, many-to-few, many-to-one, or route- and point-deviation service.

● Origin
■ Terminus
▲ Checkpoint
—— Possible Routing
- ➔ - Desire Lines

3.2.8 Institutional Arrangements

Paratransit services may be offered through a variety of institutional arrangements. They may be controlled to various degrees by local government, community cooperatives, private entrepreneurs, or social service agencies. Any attempt to graph the range of possible institutional arrangements and services quickly reduces the branching tree of the taxonomy to a tangled briarpatch. Section 6 of this review discusses institutional issues in some detail. One institutional arrangement worthy of note in this discussion is the brokerage concept, which attempts to coordinate all classifications of transit and paratransit by matching services with potential users and vice versa. Typically, the broker provides information for the transit user, but may also be empowered to schedule requests on behalf of paratransit system operators. The broker can also play a more catalytic role by identifying unmet transit needs and persuading suppliers to modify or expand their services to meet those needs.

3.3 <u>Paratransit Integration: The Scope of the Report</u>

Paratransit services may prove most effective when they are coordinated with conventional fixed-route transit systems to form an integrated transit system. There are numerous facets of service which may be integrated, including geographic coverage, scheduling, management, fare collection, resource utilization, equipment maintenance and use, and institutional arrangements. Thus, the term integration is a relative one covering a broad range of meanings. When used herein, it is intended to distinguish a service with a substantial number of integrated facets from separate transportation services operating side by side.

This report focuses on the subset of paratransit services that can be most effectively integrated with fixed-route transit. Services falling within the scope of this report are shown in the shaded portion of the taxonomy exhibit (page 1-7).

Not all paratransit services lend themselves easily to integration. Those that can be integrated are typically operated under a central dispatching control that assigns passengers to vehicles and dispatches vehicles to pick-up and drop-off points according to demand. These systems have sometimes been called demand-responsive, a term which in the past has been loosely applied to all paratransit services. Thus, the term "demand-responsive" is somewhat ambiguous, and can be interpreted to mean either real time or prearranged responsiveness.

Examination of existing systems suggests that the vast majority of paratransit installations are not currently integrated with fixed-route service, but rather operate as stand-alone paratransit services in small communities. These services are typically tailored to fit community needs by incorporating several of the options identified in the taxonomy. Many such stand-alone services reflect the characteristics included within the scope of this report, and could be integrated with fixed-route service. On the basis of recent experience, it is anticipated that stand-alone paratransit will be the fastest-growing systems of the future. Therefore, those stand-alone systems characterized by coordinated dispatching and the remaining features identified are included in this report.

Ride-sharing services which are not treated specifically in this handbook include hitchhiking, carpooling, exclusive-ride taxis, vanpooling, jitneys, limousine service, subscription bus, and automobile rental services. A guide to literature discussing certain of these omitted systems may be found in Appendix 5.

Go to Appendix A-5
Alternative Paratransit
Systems

4.0 WHAT PARATRANSIT DOES

4.1 System Objectives: Myth and Reality

A wide variety of objectives have been cited by communities as the motivation for introducing paratransit systems. These objectives reflect both long-term social goals and more immediate shortcomings in the existing transit system. The accompanying list contains a representative tabulation of paratransit goals and objectives culled from actual experience and published theory. Although the list is impressive, paratransit systems have sometimes failed to live up to the full expectations of the goal-setters. Whereas paratransit systems have the potential for fulfilling certain of the listed goals, great care is required in planning, implementing, and operating these systems if they are to be effective.

Paratransit is not a panacea for the full range of social, environmental, and mobility problems commonly associated with today's transportation systems. One of the most serious pitfalls in planning and implementing paratransit systems is the generation of high expectations which cannot possibly be met by a small fleet of buses. Clearly, the objectives set for a service should bear a realistic relationship to the service's actual potential. It is important to form an early appreciation for the likely impacts of paratransit systems to avoid misunderstandings and disappointments in later stages. Based on existing experience, the major impacts of paratransit services are likely to be:

- Improved mobility for people permanently or temporarily without access to private automobiles or high-quality transit service;
- Reduced total user cost of transportation for commuters, taxi users, and others (but not necessarily total costs to society); and

PARATRANSIT GOALS AND OBJECTIVES CITED BY EXISTING PARATRANSIT SYSTEMS

Social Objectives

- Alleviate necessity of chauffeuring non-drivers
- Increase mobility of transit dependent
- Reduce congestion, pollution, energy consumption, noise and land area needed for parking
- Reduce multiple car ownership
- Increase utilization of social, recreational and medical services
- Increase employment opportunities

Transit System Objectives

- Provide expanded service into areas not well-covered by conventional transit (transit equity)
- Replace marginal bus routes
- Feed express buses or other fixed-route systems
- Increase ridership on express buses or other fixed-route systems
- Provide more efficient off-peak service
- Identify promising patterns for conventional fixed-route service
- Improve overall system efficiency and productivity
- Provide additional peak-period capacity
- Provide higher quality service (i.e. more flexible, pleasant, reliable and convenient)
- Minimize capital investment
- Test use of new equipment and techniques
- Achieve and maintain low operating subsidy
- Provide greater personal security on transit

(Source: SYSTAN)

- Reduced congestion or parking requirements at individual employment and activity centers. (Reference 31)

Noticeably missing from the list of major impacts are the important national concerns of energy and environmental protection. Today, paratransit offers only a marginal solution to energy and environmental problems. This role may become more important in the future, in the event that energy shortages cause more riders to transfer from the automobile to alternative paratransit services.

Several situations in which paratransit is more likely to play an effective role in a community or region are listed in the table on page 1-14. The cases identified in this table all represent situations which have led to the implementation of paratransit services. The services represented have not been uniformly successful. In cases in which systems have failed, it is not always clear whether the failure was due to an inappropriate use of paratransit or to deficiencies in planning, design, or implementation. What is clear is that it takes careful analysis and a firm sense of purpose to realize the full potential of paratransit operations.

At this time in the evolution of paratransit systems, the greatest number of successes have been recorded by target market systems and by systems providing the only transit in town. Several integrated systems have proven to be successful, but there have also been some notable failures in which integrated systems have been totally or partially discontinued or replaced with fixed-route service.

4.2 The Choice of Paratransit or Conventional Transit

Conventional fixed-route transit services and flexibly-routed paratransit services have distinctly different characteristics, and certain general observations can be made regarding the relative suitability of these characteristics in specific settings. However, there are few uniformly reliable rules for selecting paratransit over conventional transit or vice versa. In Greece, New York, an attempt to replace fixed-route, off-peak buses with dial-a-ride service in corridors where transit has existed for 75 years failed. In Orange County, California, a fixed-route service replaced a dial-a-bus service because of conflicts with taxi operators. The fixed-route service drew far fewer riders and was replaced by dial-a-ride when the conflicts were resolved. The settings in each case were significantly different, but in both cases the dial-a-ride service seemed, on paper, to be the more attractive service.

In spite of the uncertainties about behavioral response to either fixed-route or paratransit, there are some general guidelines for choosing between the two services. The first factors that should be considered are the intrinsic differences in the services as they relate to the perceived needs of the potential users. Paratransit services are basically more convenient than conventional transit services, since their pick-up points and times are tailored to demand. Because paratransit routes and schedules must be flexible enough to be demand-responsive, they will generally be less reliable than fixed-route buses operating on a schedule of predictable pick-up and arrival times. Thus, the choice between paratransit and fixed-route transit may reflect a choice between convenience and predictability. For some users, such as the elderly and handicapped, the convenience of door-to-door service may be necessary.

POTENTIAL PARATRANSIT ROLES

	SITUATION	POTENTIAL PARATRANSIT ROLE
Conventional Fixed-Route Systems Exist	A sparse fixed-route bus or rail system exists with a perceived need for feeder service.	Paratransit may provide feeder service.
	A fairly dense fixed-route system exists, but is radially oriented and does not serve cross-town trips which are not radial.	Paratransit may serve cross-town trips.
	A fixed-route system exists but contains a number of very lightly used routes.	Paratransit may be used to replace lightly used fixed routes or to determine promising patterns for a modified fixed-route system.
	A fixed-route system exists but does not provide equitable coverage to the entire political jurisdiction paying the transit bill. Although political forces may be demanding "transit equity," expansion of the fixed-route system is not perceived as being cost-effective.	Paratransit may be used to increase system coverage in a more cost-effective fashion.
Conventional Transit May Or May Not Exist	There is a perceived need for service in areas expected to provide fairly low trip densities.	Paratransit may prove to be more cost-effective than conventional transit.
	There is a perceived need to provide transit service to elements of the population such as the elderly and the handicapped who either have no alternative form of transportation or who would benefit from door-to-door service.	Paratransit may be a cost-effective means of providing target market service to special population groups.
	Heavy commuting causes peak traffic congestion or air pollution, or a social goal exists to reduce vehicle miles traveled (VMT).	Subscription service may be introduced as a component of the existing service to reduce peak-period congestion.
	Many paratransit services are operated in an uncoordinated fashion by social service agencies.	Paratransit may be used to consolidate separate services, or a brokerage system may be introduced to coordinate existing demands.
No Transit Service Exists	No transit exists in an area of fairly high population density where a high potential demand is perceived, although there is little knowledge of promising transit patterns.	Paratransit may be used to test the transit market, perhaps, as a prologue to a fixed-route system or an integrated system composed of both conventional and paratransit services.

(Source: SYSTAN)

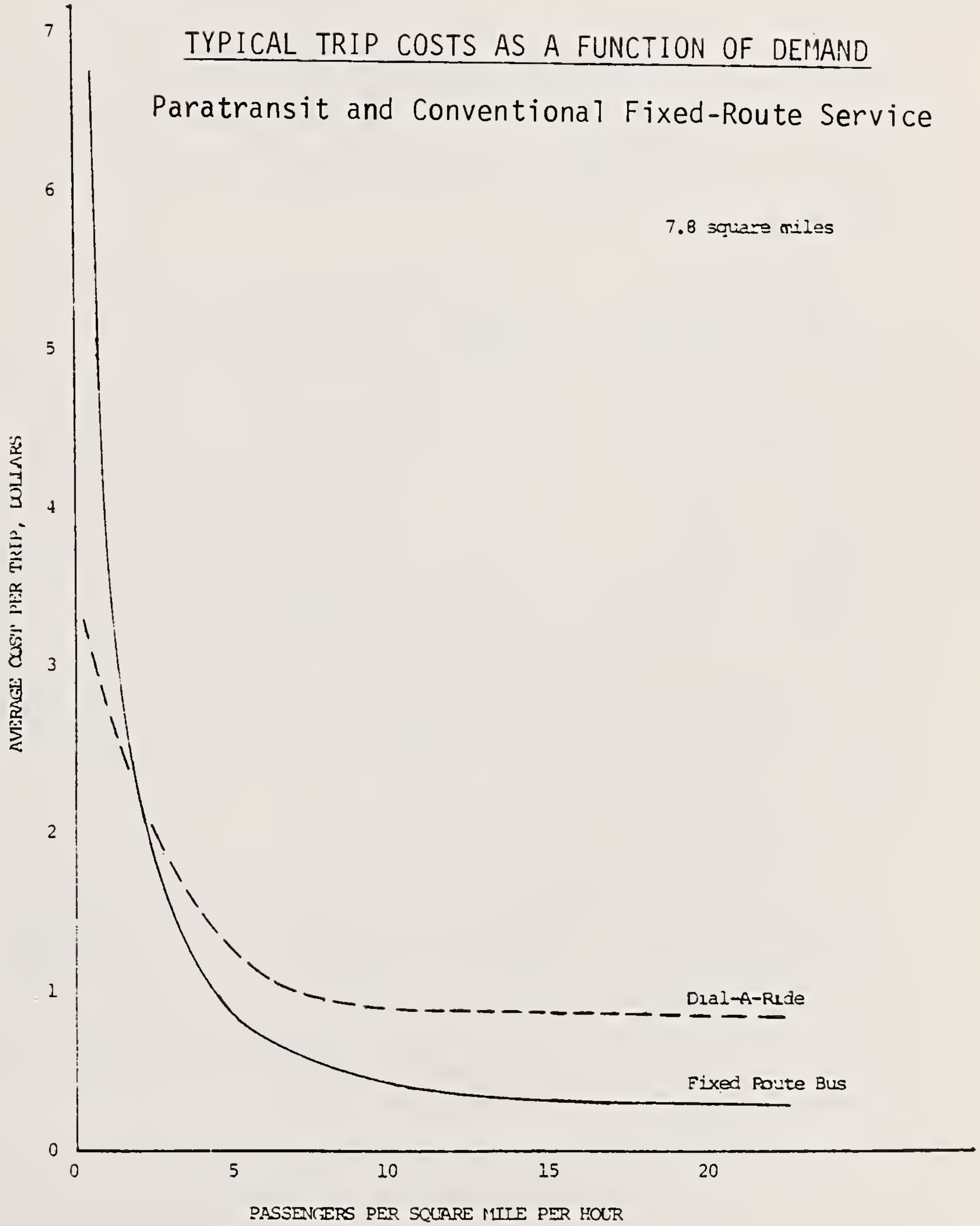
while schedule predictability may be essential to other users, such as commuters, who must be in a particular place at a fixed time.

Certain forms of paratransit service are more reliable than others. Pre-arranged subscription service, for example, can be as reliable as fixed-route bus service and may be an appropriate choice for serving a commuter market. Demand-responsive dial-a-ride systems may also be operated with an acceptable degree of reliability, but such an operation requires careful design, training, and operational debugging. "Without a strong commitment to dispatching quality and constant management attention, a Dial-A-Ride system runs a risk of providing unreliable service which is unattractive to those with needs to be in particular places at fixed times." (Reference 61)

In areas of high demand density, the productivity of fixed-route service (measured in terms of passengers carried per vehicle-hour) is significantly higher than that of paratransit service. Consequently, the cost of providing the fixed-route service is proportionally lower when vehicle operating costs are comparable. The accompanying exhibit plots typical fixed-route and paratransit system costs over a range of demand densities. The cost of fixed-route service is relatively high for low levels of demand, and drops to a relatively constant level once a minimum service level is exceeded and buses run at capacity. Since flexibly-routed service can be tailored to fit any demand level, paratransit service is less costly at low demand levels than fixed-route service. At increasingly higher demand levels, however, fixed-route service becomes less costly than flexibly-routed service. The demand level at which this crossover occurs is governed by a number of factors, including service area size; population density; minimum service levels; peak/off-peak demand patterns; the timing, orientation and lengths of the trips served; prevailing wage agreements; and union work rules. Theoretically, if prospective demand densities are less than about ten demands per square mile per hour, dial-a-ride is less costly than fixed-route service

TYPICAL TRIP COSTS AS A FUNCTION OF DEMAND

Paratransit and Conventional Fixed-Route Service



Source: SYSTAN

on a per-passenger basis, so long as other costs are comparable. Between ten and eighty demands per square mile per hour, the relative cost-effectiveness of fixed- and flexible-route services depends on other factors. If land use patterns and travel patterns suggest that the demand is concentrated in travel corridors, fixed-route service may be preferable.

Although the specific levels of the cost characteristics are dependent on a large number of factors, the general behavior of the fixed- and flexible-route curves shown in the prior graph is typical. Flexible-route service enjoys the greatest cost advantages for low demand levels in the less densely-populated areas of a region. In higher demand density areas, the number of passengers per vehicle-hour will be lower for paratransit than for transit, and the unit costs of paratransit will be higher, if operating costs are comparable. Costs are not always comparable, as many paratransit systems are operated with lower than union-scale wage rates under flexible work rules which allow part-time drivers and permit the supply of buses to adjust to the peaking of demand throughout the day. Therefore, paratransit systems may operate at comparable or lower costs than fixed-route systems, even in fairly high demand density areas.

There is evidence that in areas with demand densities sufficiently high to support some conventional transit, there may also be a role for paratransit. It is likely that future transit systems serving areas of high demand density may be hybrid systems composed of various transit/paratransit combinations, or those paratransit services--such as route and point deviation--which within themselves mix fixed- and flexible-route features.

A good deal of judgment needs to be applied in interpreting the crossover point shown in the average cost graph. At low transit mode shares, flexible-route service is considerably less risky than fixed-route service. That is, the cost of providing fixed-route service for a demand that fails to materialize can be considerably higher than the cost of providing flexible-route service sized to fit whatever demand exists. If demand does materialize, moreover, there is an upper bound on the per-trip savings available from conventional fixed-route operations. This suggests an incremental approach using flexible-route service might be a more appropriate means of introducing transit service in a currently unserved area, even if it is expected that the area demand will be large enough to justify fixed-route service. Moreover, a dial-a-ride system often has an implementation advantage for new service in areas with little or no history of transit service, as some experience suggests that demand for dial-a-ride service may develop more quickly than demand for more conventional fixed-route service (Reference 61).

A recent review of dial-a-ride operating characteristics suggests that there are at least two major areas where dial-a-ride is inferior to fixed-route service even for low-density service areas: "In the first instance, an area with some existing fixed-route service will typically have developed a hard core of bus riders who use the routed system knowledgably, and for whom it is well suited. They will be highly resistant to changes in that service, and will often regard dial-a-ride as an inferior substitute, even if it allows them service to a broader mix of destinations. Accustomed to waiting at a bus stop at known times, they will be unwilling to request service by telephone. While they will normally be counterbalanced by a much larger number of dial-a-ride users who had not previously ridden the routed service, they will complain loudly." (Reference 61) This suggests that, where demand permits, both fixed- and flexible-route service might be offered within the same area during any transition phase.

"Secondly, without special design elements such as zones with external destinations, hierarchical subsystems, and combinations with fixed-route service, long trips will be poorly served by dial-a-ride. By its very nature, dial-a-ride is circuitously routed. It should not be expected to serve trips of longer than 3-4 miles (line of sight) in suburban areas without such features." (Reference 61)

The accompanying exhibit summarizes comparable features of dial-a-ride and fixed-route systems, incorporating the discussion above and other relatively obvious points for completeness.

4.3 Shared-Ride Paratransit Versus Exclusive-Ride Taxi

As demand densities increase, paratransit modes should evolve into fixed-route transit systems or integrated combinations of fixed-route and demand-responsive systems. At the other end of the spectrum, for very low demand densities, the service provided by shared-ride demand-responsive service becomes indistinguishable from that provided by exclusive-ride taxis. If there are not enough riders to provide ride-sharing opportunities, paratransit vehicle productivity will clearly be no different from that of conventional taxi service. So long as the costs of shared-ride paratransit service and exclusive-ride taxi service are comparable, as is the case in most existing low-density systems (see Section 5), the choice between the two forms of service is marginal in areas of extremely low density (i.e., under two demands per square mile per hour). If transit union wage scales or work rules cause shared-ride service to be significantly more expensive than exclusive-ride taxi operations, which are typically offered under more flexible labor agreements, taxi service becomes the clear choice in sparsely-populated areas. In areas of low demand density in which shared-ride services are significantly more expensive than conventional taxi service, certain social aims (such as mobility for the elderly and handicapped) may best be met by providing members of the target population with subsidized rides in local taxis.

DIAL-A-RIDE VS. FIXED-ROUTE

SERVICE APPLICABILITY

(Comparing systems with the same overall service level over the same area)

Feature	Dial-A-Ride	Fixed-Route
Cost	Better comparative performance in low-density areas.	Better performance in high-density areas.
Trips Served	Best for scattered local trips.	Best for long trips in corridors.
Riders Served	Draws varied patronage, many elderly and young, miscellaneous types.	Primarily commuter oriented.
Peaking Behavior	Often shows midday peaking.	Morning and afternoon work trip peaks.
Ridership Growth	Usually shows fast growth.	Often takes many months to develop patronage.
Reliability	Weak point; needs careful and constant attention.	Easier to maintain planned service quality.
Coverage	Available equally to all service area points.	Different residences and businesses are nearer or farther from routes.

(Source: SEMTA, Reference 61)

4.4 Paratransit Versus Non-Transit Services

Improved transit service is only one of the means available for addressing the wide range of community goals commonly cited in plans for new transit or paratransit services. These goals typically include a desire for increased accessibility of community services; improved mobility for the elderly and handicapped; and reduced congestion, air pollution, and energy consumption. (See the previous list of paratransit objectives.) These goals can often be approached by steps outside the transsit planning process. Policymakers and planners should balance transit approaches against non-transit measures early in the planning process. Although many goals seem to point naturally to a transit solution, closer and more creative consideration may reveal cost-effective approaches outside the realm of transit and paratransit services.

Some non-transit approaches may be beyond the control of local planners and decisionmakers, as is the case with technological attempts to develop less polluting, more energy-efficient vehicles and fuels. Local traffic congestion, however, might be efficiently relieved by staggering local work hours. The desire to make more community services available to the elderly and handicapped might be addressed by putting the services themselves on wheels, as is the case with bookmobiles and mobile health care units. The possibility of arranging for user-side subsidies to provide taxi service for the elderly and handicapped is another alternative which may meet transit-oriented goals in a more cost-effective fashion than capital investment in new transit services.

Many passenger trips made to obtain information, purchase goods, pay bills, or prepare papers may be replaced by a combination of mail service and goods transportation. Voting and registration for social services are examples of functions often requiring personal appearance, but these functions could eventually be replaced by mail. Closed-circuit television may provide a means for bringing meetings to the homes of citizens and reducing their need for transit. Again, many of these non-transit alternatives may not be within the jurisdiction of the community, but others may be. Some of the functions served by transit also provide an element of social contact which would be lost if those functions were to be performed remotely.

4.5 Sources of Further Information

The generalities discussed in this and earlier sections provide a general framework for choosing among paratransit, conventional transit, and non-transit options, but provide little quantitative basis for making a choice in a specific situation. More detail regarding the choices available in developina a paratransit system may be found in Part II, Creating the System. To further aid in making such choices, decisionmakers should have a clear understanding of the operating characteristics of paratransit systems in a variety of settings. Appendix 4. tabulates extensive data from nearly 130 operating systems. The results of this tabulation are summarized in the next section.

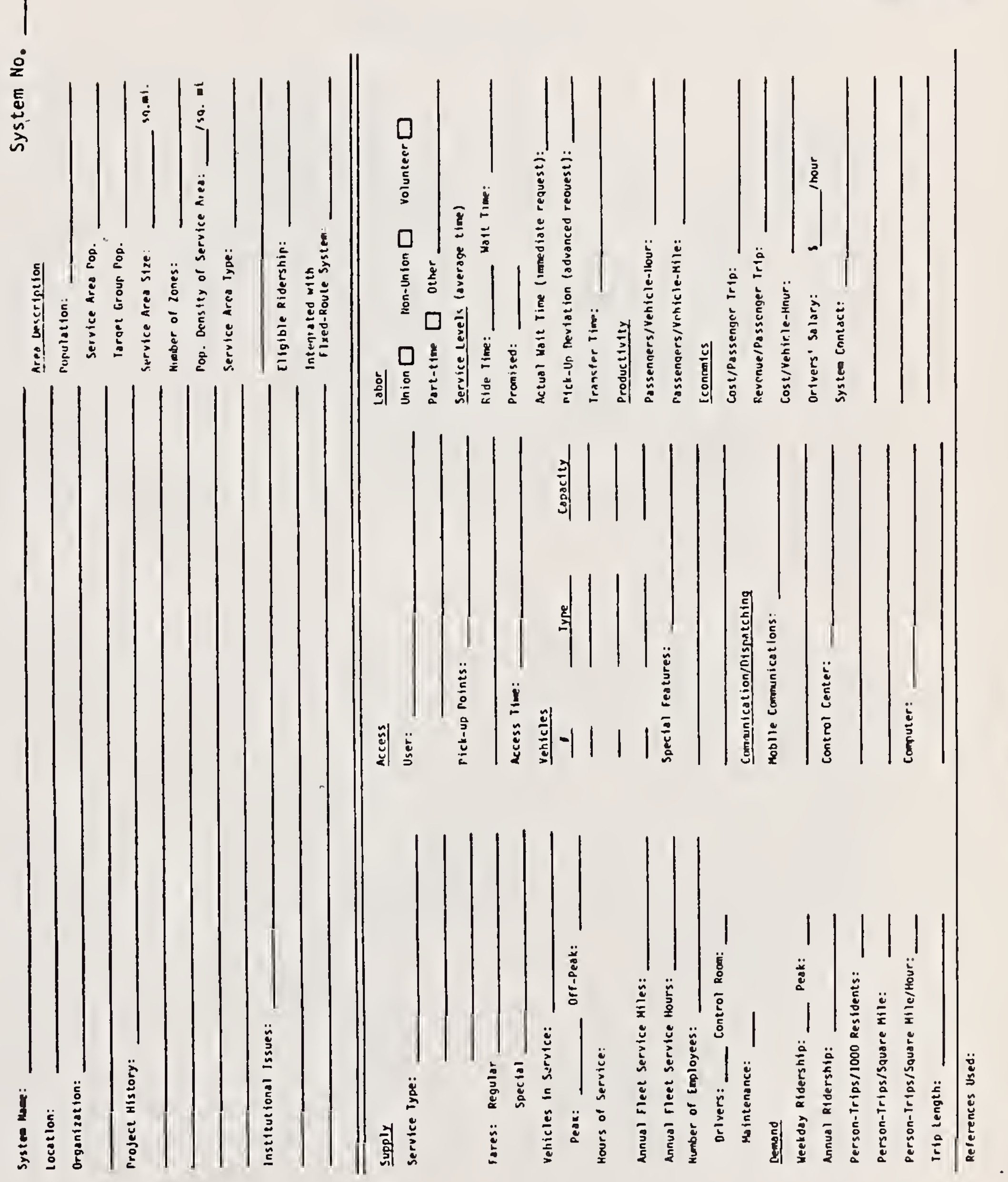
Go to Appendix A-4
System Summary
Sheets

5.0 WHAT EXISTING PARATRANSIT SYSTEMS ARE LIKE

5.1 Introduction

Information from existing paratransit systems provides a yardstick for decisionmakers considering paratransit for their jurisdictions, enabling them to predict what might be expected of paratransit systems in their own areas. Aggregate statistics indicate the range and expected value of such important factors as demand, service levels, and costs. In addition to reviewing aggregate statistics, planners and decisionmakers may wish to identify one or more existing systems which closely resemble the prospective system in configuration, area, and population served. By taking a detailed look at similar systems in similar settings, the decisionmaker adds another dimension to the review process. To aid in this process, detailed statistical breakdowns for a sample of 129 operating systems are included in this handbook (see Appendix 4). Although no two communities are alike, and the experience of one community may not provide the level of confidence needed for detailed system design, information from existing operations can greatly aid the preliminary planning process.

The systems surveyed for this report were identified by an exhaustive literature search, discussions with many paratransit professionals--planners and operators--and requests to each of the 245 Metropolitan Planning Organizations (MPO's) in the United States to identify paratransit services in their areas. Data on the systems identified in this fashion were collected by writing each system manager and requesting the set of information in the System Summary Sheets (Appendix 4), as shown to the right. A form containing the information requested is shown in Appendix 10.


System No.
System Name:
Location:
Organization:
Project History:
Institutional Issues:
Area Description
Population:
Service Area Pop.
Target Group Pop.
Service Area Size: sq.mi.
Number of Zones:
Pop. Density of Service Area: /sq. mi
Service Area Type:
Eligible Ridership:
Integrated with Fixed-Route System:
Supply
Service Type:
Fares: Regular
Special
Vehicles in Service:
Peak:
Off-Peak:
Hours of Service:
Annual Fleet Service Miles:
Annual Fleet Service Hours:
Number of Employees:
Drivers:
Control Room:
Maintenance:
Access
User:
Pick-up Points:
Access Time:
Vehicles
#
Type
Capacity
Special Features:
Communication/Dispatching
Mobile Communications:
Control Center:
Computer:
Labor
Union ☐ Non-Union ☐ Volunteer ☐
Part-time ☐ Other
Service Levels (average time)
Ride Time:
Wait Time:
Promised:
Actual Wait Time (immediate request):
Pick-Up Deviation (advanced request):
Transfer Time:
Productivity
Passengers/Vehicle-Hour:
Passengers/Vehicle-Mile:
Economics
Cost/Passenger Trip:
Revenue/Passenger Trip:
Cost/Vehicle-Hour:
Drivers' Salary: $ /hour
System Contact:
Demand
Weekday Ridership:
Peak:
Annual Ridership:
Person-Trips/1000 Residents:
Person-Trips/Square Mile:
Person-Trips/Square Mile/Hour:
Trip Length:
References Used:

(Source: SYSTAN)

Go to Appendix A-4 System Summary Sheets

Appendix A-10 Surveys: System Documentation Forms

5.2 Counting Paratransit Systems

To assess the extent of the implementation of paratransit systems with coordinated dispatching in the U.S. today, an attempt was made to count all paratransit systems falling within the scope of this study. This attempt resulted in the identification of 308 such systems; a list of these systems is included in Appendix 3. The accompanying exhibit breaks these systems down into the major classifications of general/target market and dial-a-bus (DAB)/shared-ride taxi (SRT) types. Also shown separately are three integrated systems--consisting of both paratransit and conventional transit--and six mixed systems. The mixed systems are those in which the operating entity both provides the service with its own vehicles (DAB) and contracts for service with private operators (SRT).

Target market systems which operate under coordinated dispatching are typically offered by transit authorities, counties, cities, Councils on Aging, Community Action Agencies, and Economic Development Councils. The great majority of these target market systems are intended to serve both handicapped and elderly patrons. Not included in the count are systems which are only available to social service agency clientele. An exhaustive count of all target market systems, including agency services, is difficult to obtain, since many small systems are not required to report their existence to any central authority. For example, many senior retirement homes have a single van or automobile used for collective transportation and driven by a volunteer or staff member as an incidental duty. These smaller, ad hoc services were not included in the survey of target market systems, and are not reflected in the operating statistics presented in this section.

Go to Appendix A-3 System Inventory

INVENTORY OF U.S. PARATRANSIT SYSTEMS

	General Market	Target Market	Unclassified	Total
Dial-A-Bus	74 (12)**	135 (4)**		209
Shared-Ride Taxi	42 (3)**	27 (3)**		69
Integrated	3	--		3
Mixed*	1	5 (1)**		6
Unclassified	2	11	8	21
TOTAL	122	178	8	308

* Systems which offer both DAB and SRT service.
** The numbers in parentheses indicate discontinued systems which are not included in the totals.

(Source: SYSTAN)

Some idea of the total number of target market systems in the United States has been provided in a state-of-the-art report on Transportation for Older Americans (Reference 141). This report contains estimates of 1,000 to 1,500 projects providing transportation for older Americans as of July 1974. This range was based on identification of 920 systems, including 314 which were identified by service (see the accompanying exhibit). Of this 314, about 64%--or 200--were demand-responsive or had demand-responsive components.

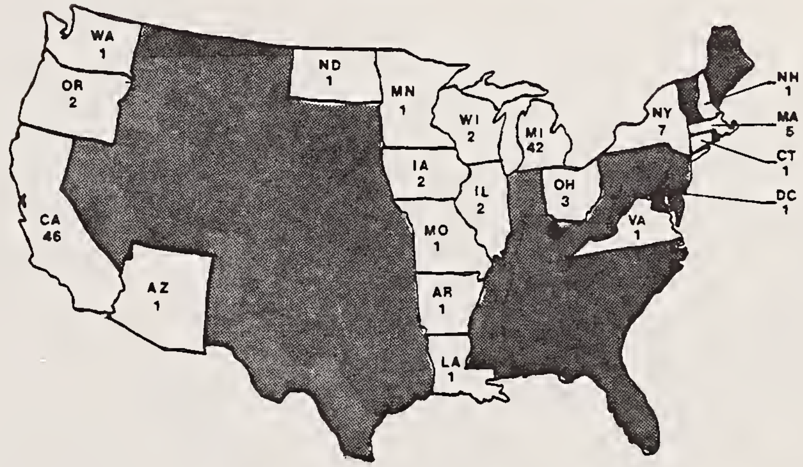
TRANSPORTATION PROJECTS SERVING OLDER AMERICANS

(By Type of Service as of July 1974)

Type of Service	Number	Percent
Demand-Responsive	112	35.7
Combined Demand-Response & Fixed Route/Schedule	88	28.0
Fixed Route/Schedule	55	17.5
Volunteer Systems	48	15.2
Taxi: Reduced Fares	11	3.6
Not Identified by Service	606	–
TOTAL	920	–
Total of Identified Projects	314	100.0

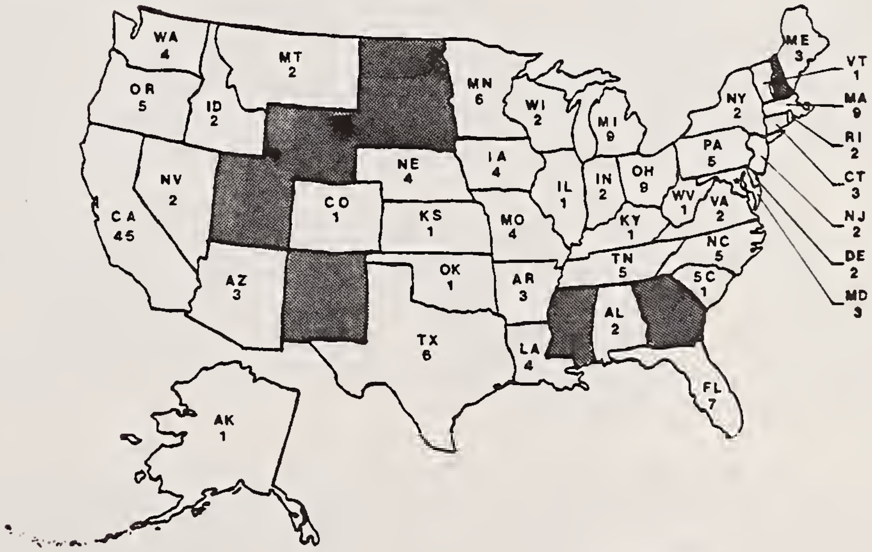
(Source: Revis, Reference 141)

122 GENERAL MARKET DRT SERVICES OPERATING IN 19 STATES AND WASHINGTON, D.C.
(March 1978)



Source: SYSTAN

178 TARGET MARKET DRT SERVICES OPERATING IN 41 STATES



Source: SYSTAN

5.3 The Location of Paratransit Services

The locations of the 122 general market systems are shown in the map on the previous page. Although no general pattern is evident, a high proportion of the services can be found in Michigan and California. One factor which may have contributed to this proportion is the presence of firms in these states which were active in early dial-a-ride research and experimentation. Both General Motors and the Ford Motor Companies in Michigan were active in dial-a-ride work. Ford provided technical assistance to the Ann Arbor system, and one of its employees who worked in dial-a-ride became executive director of the Ann Arbor Transit Authority. The Ann Arbor system had a significant influence on State legislators in Michigan, who passed legislation providing start-up financial assistance to cities implementing dial-a-ride systems. In California, many of the systems are probably the result of the marketing efforts of firms there which implement and manage dial-a-ride systems on contract. Some of these firms gained early experience in dial-a-ride as contract operators for demonstration systems. Many California cities are products of the urban sprawl which accompanied increasing automobile usage; hence, they have no transit history and are difficult to service with conventional transit. These cities are prime candidates for dial-a-ride systems, and are fertile marketing grounds for contract operators.

Target market systems are more widely dispersed throughout the United States than general market systems. The map on the previous page depicts the geographic dispersion of the 178 target market systems located in 41 states, over twice as many states as were represented in the general market sample.

The accompanying exhibit shows the type of setting served by general market and target market paratransit systems. Most of the general market systems operate in small cities, serve the entire city, and provide the only

PARATRANSIT SETTINGS

	General Market Percent of Systems	Target Market Percent of Systems
Type of Setting	(63 Systems)	(36 Systems)
Large urbanized area	1.6	33.3
Small urbanized area	19.0	25.0
Small city	61.9	16.7
Rural	17.5	25.0
	100.0	100.0
Service Area Scope	(55 Systems)	(35 Systems)
Entire city	58.2	62.9
Section of city	21.8	20.0
Urban area	10.9	28.6
Suburban area	18.2	14.3
Entire county	9.1	25.7
Rural	10.9	25.7
	129.1*	177.1*
Modes Integrated With Paratransit	(40 Systems)	(29 Systems)
Local fixed-route bus	40.0	17.2
Intercity fixed-route bus	7.5	3.4
DRT in other zones	17.5	6.9
No other service	50.0	72.4
Rail	7.5	--
Other	20.0	6.9
	142.5*	106.9*

*Multiple responses account for over 100% response.

(Source: SYSTAN)

local transit. While most target market operations also provide citywide service, they typically serve larger urbanized areas than do general market systems.

5.4 Profiles of Typical Paratransit Systems

Based on information on 119 existing systems for which fairly complete data were available, profiles of average paratransit systems are developed in this section. Part III of this report contains more detailed descriptions of existing systems, and describes the sample used to develop the profiles.

The profiles are based on median values of various site and service characteristics observed in the sample. The ranges of these variables are large in many cases, so the "typical" values tend to mask the fact that widely different systems are feasible.

Several profiles are provided for each of the following services:

- General Market - Dial-A-Bus (DAB)
- General Market - Shared-Ride Taxi (SRT)
- Target Market - DAB
- Target Market - SRT

Detailed descriptions of existing systems

5.4.1 General Market - Dial-A-Bus

General market DAB systems typically provide service in small cities and serve all or part of the city. Many cities may have areas which are impractical to serve because of terrain obstacles or low population density. In the majority of cases, the service provides the only local mass transit, although many sites also have fixed-route bus systems.

The service areas in which these systems operate have populations of about 18,000 persons living in areas of eight square miles, statistics which are typical of many small cities. Riders are served by five vehicles, dispatched manually for about 12 hours per day. The typical fare is 50¢ a ride.

Weekly ridership averages just over 200 passengers, which are generated at a range of ten trips per thousand population and at an hourly rate of 2.4 trips/square mile of service area. This demand is accommodated by carrying slightly less than six passengers per vehicle-hour. The cost of this service is about $10 per vehicle-hour, comparable to the cost of exclusive-ride taxi. The demand and cost results in a cost per passenger of $1.82 for a two-mile trip. The median revenue per trip is about $.30, lower than the standard $.50 fare due to reduced fares for elderly, handicapped and young riders. The gap between revenues and costs implies that the average system requires a subsidy of about $100,000 per year.

GENERAL MARKET

Dial-A-Bus

SUMMARY STATISTICS

(50 Systems)

AREA	Median	Range
Population (1000s)	18.0	2.1 - 244
Area (sq.mi.)	7.6	1.6 - 3372
Population Density (pop/sq.mi.)	2059	10 - 18733

SERVICE	Median	Range
Fleet Size	4.6	1 - 18
Operating Hrs/Day	12.0	6 - 24
Fares	$0.50	$.00 - 2.00

RIDERSHIP	Median	Range
Weekday Riders	206	14 - 1000
Trips/1000 Pop.	9.8	.8 - 65
Trips/Sq.Mi./Hr.	2.4	.005 - 16.7

TRIPS	Median	Range
Length (miles)	1.85	.5 - 9.5
Ride Time (min.)	14.8	7 - 30
Wait Time (min.)	15.0	5 - 37

PRODUCTIVITY & COSTS	Median	Range
Passenger/ Vehicle Hr.	5.9	1.8 - 11.0
Cost/Passenger	$1.82	$.85 - 4.47
Revenue/ Passenger	$0.29	$.21 - .59

(Source: SYSTAN)

5.4.2 General Market - Shared-Ride Taxi

Like DAB systems, general market SRT systems serve small cities but, unlike DAB, the majority serve the entire city. More SRT systems than DAB systems seem to operate in areas where other transit is available.

The median SRT system operates in an 11.4 square mile area having a population of 34,000. Fleets of roughly six vehicles are dispatched manually. These statistics all indicate that SRT systems operate in larger areas than DAB systems. This phenomenon probably reflects a tendency to constrain the boundaries of new DAB servides, while SRT services often supplement existing taxi services, which have traditionally served areas with wider boundaries. There appear to be no inherent design or operating features which would make SRT superior to DAB in larger service areas, except perhaps the greater mobility and maneuverability of automobiles as compared to buses. Like DAB systems, SRT services are available for about 12 hours a day at a base fare of $0.50.

Roughly 260 riders use SRT systems each weekday (25% more than use DAB), but riders are generated at rates (measured by per capita population or per square mile per hour) of about half those found in DAB systems. About 5.5 passengers are carried each vehicle-hour, at a per vehicle-hour cost of $10.00. These figures are essentially equivalent to DAB statistics.

The SRT cost per passenger is a little lower than that of DAB systems, while the revenue recovery is 50% higher. Although the net cost per passenger is lower, the annual subsidy required for SRT is about the same as for DAB systems.

GENERAL MARKET

Shared-Ride Taxi

SUMMARY STATISTICS

(28 Systems)

AREA

	Median	Range
Population (1000s)	34.2	10.5 - 315
Area (sq.mi.)	11.4	4 - 151
Population Density (pop/sq.mi.)	4110	838 - 13478

SERVICE

	Median	Range
Fleet Size	5.8	1 - 75
Operating Hrs/Day	12.0	7 - 24
Fares	$.50	$.15 - 1.00

RIDERSHIP

	Median	Range
Weekday Riders	260	20 - 3200
Trips/1000 Pop.	4.3	1.0 - 27.6
Trips/Sq.Mi./Hr.	1.4	.2 - 5.0

TRIPS

	Median	Range
Length (miles)	2.6	.8 - 3.7
Ride Time (min.)	10	1 - 20
Wait Time (min.)	15	2 - 27

PRODUCTIVITY & COSTS

	Median	Range
Passenger/ Vehicle Hr.	5.5	2.85 - 8.7
Cost/Passenger	$1.70	$1.05 - 2.94
Revenue/ Passenger	$ .45	$ .37 - .92

(Source: SYSTAN)

5.4.3 Target Market - Dial-A-Bus

The median target market DAB system serves portions of a 100 square-mile urban area with a population of 159,000, about 10% of whom are eligible for the service.

The DAB fleet consists of about five vehicles operating about 11 hours each day at fares of $0.50.

Weekday ridership is about 130 passengers, generated at eight rides per day per 1,000 eligible persons. Measured by riders per vehicle-hour, vehicle productivities average 3.0, about half those of general market systems. These low productivities may be traced to the large service areas and the relatively long trips of 4.4 miles served by these systems.

The median cost per vehicle-hour of $13.00 is higher than the median of the general market systems, and the median cost per passenger of $4.05 is much higher due to the lower productivities.
The annual subsidy required to operate these systems is higher than that of general market systems and fewer riders are served, but larger service areas are covered.

TARGET MARKET

Dial-A-Bus

SUMMARY STATISTICS

(29 Systems)

AREA

	Median	Range
Population (1000s)	159	6 - 3367
Eligible Pop. (1000s)	15.4	.075 - 220
Area (sq.mi.)	106.0	.8 - 5700
Elig. Pop. Dens. (pop/sq.mi.)	150	2 - 953

SERVICE

	Median	Range
Fleet Size	5.2	1 -50
Operating Hrs/Day	10.8	6 -18
Fares	$.005	0 - $1.00

RIDERSHIP

	Median	Range
Weekday Riders	132	7 - 1480
Trips/1000 Elig. Riders	8.0	.9 - 1467
Trips/Sq.Mi./Hr.	.15	.001 - 2.44

TRIPS

	Median	Range
Length (miles)	4.4	.8 - 150
Ride Time (min.)	20.2	3 - 90
Wait Time (min.)	20.2	5 - 35

PRODUCTIVITY & COSTS

	Median	Range
Passenger/ Vehicle Hr.	3.0	1.0 - 16.2
Cost/Passenger	$4.05	$.34 - 10.72
Revenue/ Passenger	$ .37	$.08 - 2.10

(Source: SYSTAN)

5.4.4 Target Market - Shared-Ride Taxi

Very little data are available on target market SRT services. The data that are available suggests that these systems operate in small urbanized areas or small cities, and serve the entire city. The median area is 22 square miles in size and contain about 60,000 people, about 5% of which are eligible for the service. These areas are considerably smaller than target market DAB service areas.

The median fleet of four vehicles provides service nine hours per day at a $.50 fare.

About 20 to 30 riders per thousand eligible population ride each day, for a weekday ridership of 50 passengers.

Reliable cost data for target market SRT services were not available from the survey due to the small number of respondents.

TARGET MARKET

Shared-Ride Taxi

SUMMARY STATISTICS

(7 Systems)

AREA

	Median	Range
Population (1000s)	60.0	20 - 121
Eligible Pop. (1000s)	3.0	2.2 - 7.0
Area (sq.mi.)	22.0	3.0 - 94
Elig.Pop.Dens. (pop/sq.mi.)	200	88 - 320

SERVICE

	Median	Range
Fleet Size	4.0	1 - 32
Operating Hrs/Day	9.2	8 - 12
Fares	$.50	$.25 - .50

RIDERSHIP

	Median	Range
Weekday Riders	50.0	14 - 285
Trips/1000 Elig. Riders	26.7	10.3 - 40.5
Trips/Sq.Mi./Hr.	.83	.01 - 5.74

TRIPS

	Median	Range
Length (miles)	2.0	0.5 - 3.8
Ride Time (min.)	15.5	15 - 20
Wait Time (min.)	25.5	15 - 45

PRODUCTIVITY & COSTS

	Median	Range
Passenger/ Vehicle Hr.	6.7	1.91 - 6.8
Cost/Passenger	$2.11	-
Revenue/ Passenger	$ .50	-

(Source: SYSTAN)

6.0 OFF-THE-ROAD ISSUES: THE MAJOR ISSUES IN PARATRANSIT

The major factors influencing the growth and development of paratransit systems are neither technical nor operational, but rather off-the-road issues reflecting institutional arrangements or constraints. These issues include:

1. The coordination of existing paratransit service;
2. The availability of funding
   a. The competition between conventional and paratransit systems
   b. Barriers to private operators;
3. The effective use of the taxi industry;
4. The cost of paratransit service
   a. Labor
   b. public versus private operation
   c. Insurance;
5. Local regulations
   a. Restrictions on shared-ride taxis
   b. Insurance;
6. Federal regulations; and
7. Federal policy for elderly and handicapped users.

This list does not include all off-the-road factors affecting paratransit, but does attempt to identify the most significant issues, many of which will require national attention. These issues do not fall into tidy packages; rather, as the subheadings indicate, they are highly interrelated. Each issue is discussed in the subsequent sections of this chapter.

6.1 Major Issue: Coordination of Existing Services

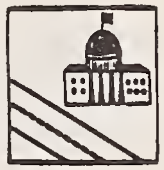
6.1.1 Organizational Considerations

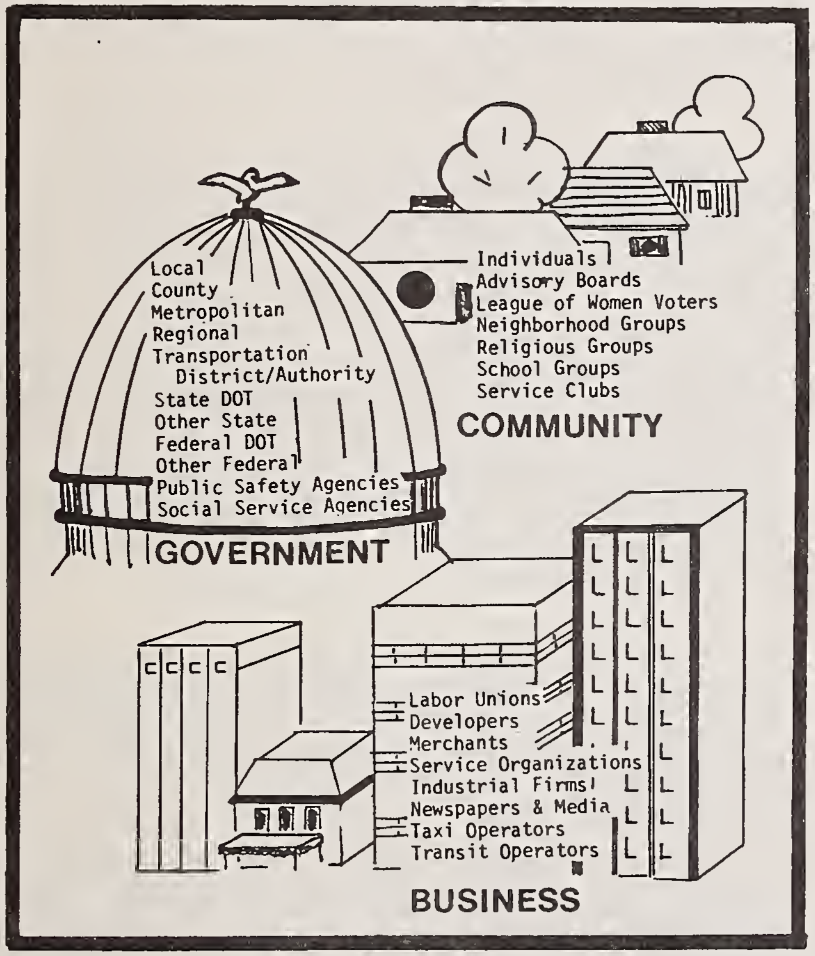
(A) Participants

A number of organizations in every community have an interest in transportation. There are those who plan, advise, fund, manage, operate, use and control (through regulation, politics, etc.). These roles are organized in a variety of often complex institutional arrangements involving many participants. Combinations of roles exist as well; for example, planning and operation may be done by the same organization. The following exhibit shows the array of groups concerned with transportation decisions. During preliminary planning, the affected groups should be included in discussing proposed plans, formulating the role and composition of advisory groups, and selecting the mechanisms for soliciting community input and informing the public of proposed plans. An assessment of the support of both the political community and local citizenry will provide a preliminary indication of the feasibility of initiating a paratransit system.

(B) Organizational Structures

In the past, most demand-responsive paratransit systems have not been developed through traditional, formal planning processes, or in organizational structures of any size or complexity. Paratransit systems have been called "guerilla systems." They have typically grown out of local, often unserved, transportation needs and have been characterized by informal organizational arrangements.





A variety of organizational structures currently exist. The most common are:

Public Paratransit as a Part of Transit Operations:

- Paratransit organization is fully integrated with a fixed-route system (Ann Arbor, Michigan).
- Paratransit is a separate organizational unit within a transit organization (Rochester, New York; Syracuse, New York).

Public Paratransit as a Part of Local Government:

- Paratransit is publicly-owned and managed by a unit of local government (many of the Michigan dial-a-ride systems).
- Paratransit is publicly-owned and managed by a private contractor, either a management and operations (M&O) contractor or a taxi operator (El Cajon, La Mesa, La Habra, and La Mirada, California).
- Paratransit is privately-owned and managed and may provide contractual service for local government (subsidized taxi operations).

Private For-Profit Paratransit:

- Paratransit is privately-owned and operated without subsidy (Little Rock, Arkansas).

Private Not-for-Profit Paratransit:

- Paratransit is organized by a community cooperative which contracts for service (OATS, Missouri)

- Paratransit service is provided by a social service agency and integrated with other elements of their programs (almost all urban areas).

Although these arrangements are the most common, alternative arrangements also exist. The brokerage concept has received much attention recently, and is being applied in Knoxville, Tennessee. The brokerage function in Knoxville is carried out by a newly-formed department within the city government. The "broker" acts as a facilitator who "marries" supply and demand, bringing together the providers of transportation and the potential users of the services.

6.1.2 Coordination Concerns

The delivery of paratransit services, particularly by social service agencies, has been characterized by a lack of coordination resulting in inefficiencies and duplication of service. The potential benefits of a well-coordinated service are many.

Over two billion dollars were spent in fiscal year 1976 (Reference 106) by all federal programs that "provide transportation of people in support of program goals." Among the recipients of these funds were the various social service agencies who either operate their own paratransit service or contract for it. In fiscal year 1976, the Departments of Health, Education and Welfare, Housing and Urban Development, Interior, and Labor provided over $200 million for the transportation of people in support of their programs. Thus, significant sums of federal monies are being spent on transportation by agencies that are not in the transportation business. If this funding were available to support coordinated services, very high levels of service might result. Instead, the fragmentation of the federal funding programs has created a corresponding fragmentation of services at the local level. It becomes especially frustrating to those at the local level to see so much funding available for transit but so little available for community-wide services.

Although the possibility of coordinating and perhaps consolidating these services is attractive, the social service agencies themselves are concerned about giving up their existing procedures. They fear that if their transportation needs were to be met by an agency outside their control, the reliability of the services might suffer. Agencies using part-time or volunteer drivers sometimes fear that their transportation costs would escalate; this fear can be traced to the high vehicle-hour costs of most public transit systems. Moreover, the transportation funding provided to these agencies may provide complementary, non-transportation benefits for the agency staff.

Private operators who contract with social service agencies to provide transportation sometimes fear that any consolidation of services would involve public operation, resulting in a loss of business for the private entrepreneur.

The magnitude of funding and the duplication and fragmentation of services has motivated local and regional representatives to search for ways to coordinate these services. As an example, the Metropolitan Transportation Commission (MTC), which oversees federal funding in the San Francisco Bay Area, has recently enacted a regulation which requires agencies seeking approval of funding applications to belong to a "Paratransit Coordinating

Commission." MTC's intent was to increase the "cooperation, coordination, availability, and effectiveness of special transportation services by minimizing overlap and duplication in the use of resources." In Michigan, an effort is being made to achieve coordination by proposing that all planned transportation services funded by any state department be reviewed by the state department of transportation. "The objective is to ensure that no overlap in transportation service provision exists and that recommendations for maximizing the purchasing potential of available funds can be realized." (Reference 118)

Attempts at coordination will continue, and new concepts will evolve and be tested. Federal funding agencies could also take action to motivate coordination. However, fragmentation presently results in the ineffective use of resources and is a major issue in the development of effective paratransit systems.

6.2 Major Issue: Availability of Funding

Funding is the problem most frequently cited by the paratransit operators surveyed; 61% of those responding classified it as a problem, while an additional 20% felt it was a severe problem. Until recently, paratransit has been treated as a stepchild, receiving few of the funding grants awarded under the National Mass Transportation Act. As Kirby et al. (Reference 1) pointed out, capital grant money has traditionally gone to conventional bus and rail services. Only in the past few years has any capital grant money been expended on paratransit services. Funds for dial-a-ride demonstration projects have amounted to $7.4 million, or 3.4% of the total RD&D funds for 1966-1973 (Reference 119).

Instead of receiving federal support, operating assistance monies generally must be pried loose from a transit district or regional transit authority which may be committed to a conventional transit system. Moreover, private taxi operators -- who provide most of the existing paratransit services -- are not eligible for direct federal operating grants.

On the other hand, there is growing interest in paratransit at the federal level, as indicated by the growth of research and demonstration funding of paratransit projects and the proposed federal paratransit policy. There are still constraints on federal funding, however, in terms of operator eligibility and labor-protective legislation.

Although there is a shortage of federal funding for paratransit, local political bodies seem convinced of the value of paratransit services, as many provide support with local funds. Fifty-six percent of the systems surveyed used some or all local funds to cover operating costs. The sources of these funds are property tax revenues, federal revenue-sharing funds, and Community Development Block Grants.

There are indications that state governments are also sensitive to the benefits of paratransit. Michigan has established a program to provide 100% funding in the first year to local communities who contribute $1,000 for dial-a-ride projects. At the end of the year, the communities have the option to buy the equipment for $1.00. Texas reserves 40% of its operating aid for cities under 200,000 population. California designates that 5% of its operating assistance funds to transit districts can be used for community transit, and many of the resultant systems are of the paratransit variety.

6.3 Major Issue: Effective Use of the Taxi Industry

In 1975, taxi operations outgrossed all other transit modes ($3,358 million to $1,861 million), and carried 37% as many revenue passengers as all conventional transit modes (Reference 92). Taxi vehicle-hour operating costs probably averaged slightly less than $10, compared to an estimated average of over $20 for fixed-route buses. These comparisons portray a cost-effective industry which provides a significant portion of urban transportation. More complete comparisons of this type are shown in the exhibit below.

COMPARISON OF TAXI AND TRANSIT INDUSTRIES
(1975)

	Taxicab Industry	Transit Industry (Rail & Bus)
Vehicles (thousands)	193	62.3
Annual Revenue Passengers (millions)	3,104	5,626
Annual Passenger Revenue (millions $)	3,358	1,861
Annual Vehicle-Miles (millions)	7,739	1,990
Employees (thousands)	365	160

(Source: CDC/Wells, Reference 92)

Some trends and conditions will continue to affect the taxi industry. These include the constraints of local regulations on operating in an exclusive-ride mode; the escalating costs of fuel, vehicles and insurance; the dependence for income on fares which have necessarily risen and have negatively affected ridership; and the new, publicly-subsidized, shared-ride paratransit services which may compete with taxis. The extent to which these conditions threaten the viability of the taxi industry is not clear. However, the exclusive-ride taxi is an important service and should be preserved. There are over 2,000 communities whose only public transportation is the taxicab. Many economies could be realized by using the resources of the taxi industry more intensely. The equipment, management, and driver know-how can be used to provide cost-effective shared-ride paratransit.

6.4 Major Issue: The Cost of Paratransit Service

Most paratransit services have lower vehicle productivities than conventional fixed-route systems because of the intrinsic personalized nature of their operation. Exceptions occur in the case of certain subscription bus services, which may have productivities equivalent to conventional bus systems, and in sparsely-populated areas where fixed-route transit cannot attract sufficient aggregated demand to realize higher productivities than a demand-responsive system.

Labor accounts for about 60% of transit expenses in both fixed-route and paratransit operations. Therefore, if similar wage rates prevail for fixed-route and paratransit alternatives in a relatively high-demand area, the paratransit system is likely to have higher costs per passenger due to the higher productivities of fixed-route systems. Where dial-a-bus systems have operated in an integrated system together with bus transit, as in Rochester, New York and Santa Clara County, California, the dial-a-bus systems have had higher costs per passenger. Although the services are different and it can be argued that the personalized nature of dial-a-bus is a premium service which warrants higher cost, in both Rochester and Santa Clara County, and more recently in Ann Arbor, Michigan, the issue of the higher cost of dial-a-bus service became a major concern to political decision-makers. In Santa Clara County, the decision not to reflect the higher cost in proportionally higher fares was one of the factors which led to early system overloads.

The cost of service is partly a labor issue because of the labor-intensive nature of transit. This is indicated by the fact that in four cities operating general market systems under labor agreements with national transit unions (ATU or TWU) and in Ann Arbor, which had a local union, the means of the cost per passenger, hourly vehicle costs, wage rate and employee fringe benefits were all significantly higher than the comparable mean figures for all reporting non-unionized operations (as shown in the exhibit to the right). The operating costs of the unionized systems would be even higher if the figures were adjusted for inflation to a common year.

At the local level, the issue of cost is related to the choice of public or private provider. Public providers are more likely to be unionized, especially if a transit operation already serves the area. The

SERVICE AND LABOR COSTS

	Cost/ Passenger	Cost/ Veh.Hr.	Drivers Wage	Drivers Fringe
Systems with Unionized Labor:				
# 46 Haddonfield (1974)	3.45	19.90	5.67	35%
# 48 Columbus (1971-72)	7.56	16.64	8.00	--
# 80 Ann Arbor (1976-77)	3.54	19.85	5.15	53%
# 81 Greece (1975)	3.74	16.64	5.90	35%
# 81 Irondequoit (1976)	7.50	24.82	6.61	43%
Means	3.90	19.57	6.27	41.5%
Systems with Non-Unionized Labor				
Means	2.02	10.93	3.60	24.7%
Number of Systems	33	29	11	6

Source: SYSTAN

issue of labor and cost also relates to the availability of funding. Except for monies specifically allocated for target market services (UMTA Section 16(b)(2)), federal transit funds are available to transit operators only with the concurrence of unionized labor (UMTA Section 13(c)), which essentially "promotes" the use of unionized labor or equivalent wages and work rules. Some relaxation of these constraints seems likely in the proposed UMTA policy on paratransit. Even in cases where a transit authority is free to use private non-unionized paratransit operators, difficulties may arise if the private operation is to be coordinated with a public, unionized operation. Resentment and competition may impede successful coordination.

Another cost factor that limits the supply of paratransit operations is the high cost of insurance for common carriers. Prohibitive insurance costs have constrained entrepreneurial-minded commuters attempting to organize vanpool services to their place of employment. If they carry more than a specified number of passengers, they are deemed to be a common carrier by the local Public Utilities Commission, and are subject to relevant regulations which usually require them to obtain costly liability insurance. In some jurisdictions, non-profit organizations have been created to buy and insure vans to help reduce these costs by increasing the number of vehicles covered.

6.5 Major Issue: Local Regulation

6.5.1 Regulatory and Legal Considerations

"Funding affects what can be done; regulation affects what can't be done; together they affect how it can be done" (Reference 114). Or, as a taxi man expressed his views on regulation, "if it's not in the ordinance, you can't do it." Regulation is often viewed by the operator and the public in negative terms, although most regulations are instituted to protect both the operator and the consumer. The provison of new paratransit services has left many regulatory questions which are not easily answered by existing ordinances. Daniel Roos of the Massachusetts Institute of Technology has pointed out that:

1. Existing regulatory structures are often mandated by enabling laws that predate World War II and that conceptually lack a definition of many paratransit alternatives; and

2. The existence of a dual regulatory structure operates to prevent the effective coordination and integration of different paratransit and conventional transit services. (Reference 114)

Currently, there is a great deal of scrutiny of existing regulations, as the needs for and of paratransit have made some of the "can't do's" obsolete. Some of the regulatory shortcomings which have been identified include the lack of:

1. Uniform definiton of classes of ground transportation;

2. Uniformly-acceptable nomenclature;

3. Definition of boundaries in matters of jurisdiction;

4. Commonly-defined areas subject to regulation;

5. Uniformly-acceptable degrees of regulatory control;

6. Common purpose and constituency of the regulatory bodies and legislative entities responsible for establishing laws and ordinances; and

7. Proper definition of the public interest.

6.5.2 The Regulators

The exhibit at the right matches regulatory areas with the various levels of government having that area under their regulatory purview. The large number of regulatory bodies and regulation areas shown in this exhibit serves to illustrate the complexity of paratransit regulation.

6.5.3 The Regulated

Paratransit regulations can also be related to the type of service offered. Shared-ride taxi is illegal in most U.S. cities. In addition, Kirby et al. (Reference 1) list the following as areas of taxi regulation which tend to constrain their use in providing paratransit service:

1. Entry control (limiting the number of cabs, restricting the number of cab firms, and regulations allowing monopolistic operations);

2. Financial responsibility (public liability insurance);

PROFILE CHART OF REGULATORY FRAMEWORK

Regulatory Body	Areas Subject to Regulation: Rates and Fares	Insurance	Equipment	Drivers	Route	Licensing and Taxes	Fees	Accounting	Entry Control
Federal									
Interstate Commerce Commission	x	x			x			x	x
Federal safety standards			x						
Airport commission	x	x	x	x	x		x	x	x
State									
Public utility commission or state corporation commission	x	x	x		x	x	x	x	x
Department of motor vehicles		x	x	x					
Airport commission	x	x	x	x	x		x	x	x
Secretary of state	x	x	x	x	x	x	x	x	x
Department of transportation	x	x	x	x	x	x	x	x	x
County									
Department of motor vehicles		x	x	x		x			
Public utility commission	x	x	x	x	x	x	x	x	
Airport commission	x	x	x	x	x		x	x	x
Department of transportation	x	x	x	x	x	x	x	x	x
City									
Department of motor vehicles		x	x	x		x	x		
Police department			x	x		x			
Taxi commission		x	x	x		x	x		x
Airport commission		x	x		x		x		
Department of transportation	x	x	x	x	x	x	x		
Joint metropolitan commission									
Port authority	x	x	x		x		x	x	x
Area transit commission	x	x	x		x		x		x
Airport commission	x	x	x		x		x		

Note: x indicates the area that is subject to regulation by the regulatory body.

(Source: Wolfington, Reference 119)

3. Service standards (vehicle design and safety standards, driver qualifications, and restrictions on methods of operation; and

4. Fares (level of fares, rate structure).

Dial-a-ride service is generally regulated by a public service or utility commission, and must also meet state-imposed motor carrier regulations (Reference 1).

6.5.4 Paratransit in the Courts

Legal action by taxi companies has affected the implementation of new paratransit systems. The six issues at the right are at the heart of the allegations.

6.6 Major Issue: Federal Policy and Regulations

On October 15, 1976, UMTA proposed a policy on paratransit services which included the criteria to be used in funding such services. Earlier regulations issued jointly by UMTA and FHWA in September 1975 emphasized the need for local governments to consider paratransit services in their transportation improvement programs. Paratransit services are defined as "collective (shared-ride) transportation services which are regularly available to the public, i.e., which cannot be reserved for the private and exclusive use of individual passengers" (Reference 8).

The proposed UMTA paratransit policy states that local taxi and private transportation operators should be allowed to participate in the development of local transport plans and programs. In addition, UMTA would not fund a paratransit service for a public transit operator

PARATRANSIT IN THE COURTS

1. Compliance with UMTA grant requirements. In Westport, Connecticut, a taxi firm argued that a demonstration project (using UMTA Section 6 funds) should be subject to the stricter UMTA capital grant conditions (UMTA Section 3) funds which recognize the more permanent effect of such funds on the community. The court ruled that since the service was being offered as a demonstration, the Section 3 provisions did not apply. This decision was appealed and, in January 1978, the U.S. Court of Appeals also ruled against the taxi company but disagreed with the lower court's findings. The appeals court ruled that the Westport Taxi Service was not a mass transportation company because it operated under a taxi ordinance allowing shared-ride only with the consent of the first rider. The taxi company was therefore not eligible for protection under Section 3(e). Although significant, this decision does not completely define when a taxi company does or does not offer a mass transportation service (see 6. below).

2. License provisions granted by a municipality. In Ann Arbor, Michigan, a taxi company argued that the city, by granting it a license to provide taxi service, implicitly agreed not to engage in competitive services such as the new dial-a-ride system. The court ruled that there was no exclusive franchise granted to the taxi company. In Westport, Connecticut, the taxi company argued that the "certificate of public convenience and necessity" guaranteed them freedom from competition from the government. The court decided that, as there was no explicit guarantee in the certificate, no violation occurred and, further, franchises granted in the public interest should favor the public.

3. Deprivation of property without adequate compensation. This claim stems from interpretation of a license or certificate as the receiver's property. In four separate cases (Ann Arbor, Michigan; Westport, Connecticut; St. Joseph-Benton Harbor, Michigan; and Merced, California), the courts ruled that competition from the government, by itself, does not constitute the taking of property.

4. Equal protection under the law. This issue was based on whether paratransit services and taxis should be regulated in the same way. In Ann Arbor, the taxi company argued that the dial-a-ride service was the same service as that offered by the taxis. The court ruled that dial-a-ride was not an exclusive-ride service nor could passengers control the vehicle's route, and this excluded them from taxi-licensing requirements.

5. Unfair competition. The issue of unfair competition in Ann Arbor was decided when the court ruled that it was not the intent of the transit district to market its services as those of the taxi company.

6. Buy-out provisions of transit-enabling statutes. In Santa Clara County, California, the legislation that created the county transit district included a buy-out provision for existing transit systems in the district. The taxi companies in the district qualified as both "existing" transit systems, since 40% of their operating revenue came from service within the district, and as a "transit system" since transit was defined broadly as "transportation of passengers and their incidental baggage by any means." In Orange County, California, the legislation creating the transit district used a narrower definition of existing mass transit systems. When the transit district was sued by a taxi company, the taxis did not come under the definition of mass transit service as "transportation of passengers only and their incidental baggage by means of a vehicle or some form of an individual fare-paying basis" (i.e., the passengers pay the scheduled fare). The court ruled that since: (1) taxis charge a flat fare in which the vehicle is hired and the fare is constant, and (2) 1% of the taxi business came from delivery of packages and telegrams, they did not meet the definition of a mass transit service.

(Source: Summarized from Gundersen, Reference 107) in competition with an existing or proposed private paratransit service unless the private operators were given an opportunity to bid for the provision of the service. The proposal states:

> Pursuant to this policy and to Section 3(e) and 4(a) of the Act, UMTA will not provide financial assistance to any publicly-owned mass transportation company or private non-profit organization for the purpose of operating paratransit services in competition with paratransit services already being provided by an existing local taxi operator or other private transportation provider, unless it finds that the officially-developed local transportation program provides to the maximum extent feasible for the participation of private transportation companies (whether or not such companies are providing at the time mass transportation services).
>
> A local transportation program will be found to provide for maximum feasible participation of private transportation companies if it offers local taxi operators and other private transportation providers full opportunities to bid for the provision of any new paratransit services that might be proposed by public bodies for the implementation with the assistance of UMTA funds; and if it provides for the selection of the service provider competitively, on the basis of the highest efficiency and effectiveness, and least cost. (Reference 8)

The proposed UMTA policy also states that:

> Where an organization is providing paratransit service as an incidental adjunct to its main business, UMTA will not consider such organization to be a mass transportation company within the meaning of Section 3(e) of the Act, or a mass transportation company or system with employees entitled to protection under Section 13(c). For example, a private taxi operator providing shared-ride paratransit services or contract services to a public transit authority, e.g., to provide special transportation services for elderly and handicapped persons, could be held to be providing such services on an incidental basis to its main business. (Ibid.)

However, recent Department of Labor rulings have found taxi companies to be providing "mass transportation" services and have extended 13(c) coverage to certain taxi company employees. In a recent Pittsburgh, Pennsylvania brokerage project grant, the Department of Labor ruled that 15% of Colonial Taxi's business was similar to the "mass transportation" service offered under the grant, and the taxi company employees who provided this service were to be covered by the local transit authority-union 13(c) agreement. In New Haven, Connecticut, the Department of Labor rules if 50% of a taxi employee's time is spent providing shared-ride service similar to that to be funded in a Federal operating assistance grant, then 13(c) protection is to be extended to these employees.

While this policy is intended to encourage privately-operated paratransit, conflicts still exist with the Urban Mass Transportation Act's labor protection provision, Section 13(c). The Department of Transportation policy is not in harmony with that of the Department of Labor, and will probably undergo major revisions before it is issued. Essentially, UMTA is not to give assistance where reduced employment for conventional transit services would result, even though, as Kirby at al. (Reference 1) pointed out, "some of the transit services being provided might be highly inefficient. For example, the federal dial-a-ride experiment in Haddonfield used small buses and employed bus drivers largely because of Section 13(c), when taxicabs might have been a better choice on efficiency grounds. Local officials may therefore be placed in the uncomfortable position of having either to support an inefficient transit system or do without federal funds for public transportation."

The 13(c) section of the UMTA act has been the subject of much controversy, and its implications are not widely understood. In a recent court ruling in New York over Section 13(c) between the Syracuse Regional Transportation Authority and the local ATU union, the court ruled that "13(c) was intended to preserve the rights of employees and to maintain the status quo with respect to the employer's obligation to bargain collectively, not to create new rights for employees or enhance existing ones" (Reference 114). While this may be true, labor will naturally use the provision to negotiate for the inclusion of paratransit systems in their agreements:

> In demand-responsive transit, the arena for much of the contention about 13(c) has been the demonstration projects sponsored by UMTA. In the Haddonfield, New Jersey and Rochester, New York demonstrations, union labor was employed and paid the prevailing wage. The Rochester union agreement is considered a model by organized labor of how dial-a-ride should operate.
> (Reference 101)

6.7 Major Issue: Federal Policy Regarding Elderly and Handicapped Users

Federal policy dictates requirements for assuring that transit systems are accessible to elderly and handicapped users. Section 16 of the Urban Mass Transportation Act of 1964, as amended, states that "It is hereby declared to be the National policy that elderly and handicapped persons have the same right as other persons to utilize mass transportation facilities and services... (and) that special efforts shall be made in the planning and design of mass transportation facilities and services so that the availability to the elderly and handicapped persons of mass transportation which they can effectively utilize will be assured..."

More recently, Executive Order 11914 (April 28, 1976) stated that every department of the government should establish specific standards for implementing non-discrimination policies as spelled out in Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794).

The proposed rules for implementing Section 504 in the Department of Transportation were listed in the Federal Register, Volume 43, No. 111 (June 8, 1978). The rules state that recipients must "make each program or activity (in a transit system) accessible when viewed in its entirety, but each existing facility or part of a facility need not necessarily be accessible to or usable by the handicapped." Exactly what this implies in practice is yet to be determined.

These regulations affect both conventional transit and paratransit, and may impact the balance between the system types. Many transit jurisdictions planned to make public transportation accessible to the elderly and handicapped by initiating paratransit service rather than by investing in capital improvements for conventional systems. The reasoning behind this strategy is expressed in the position of the Rochester-Genesee Regional Transportation Authority (RGRTA):

> The introduction of accessible coaches to fixed-route service in the Rochester urban area will not, in our judgment, make public transportation available to a significant number of mentally, physically, or emotionally disabled persons. Rather, implementation of the technology prescribed in the proposed Regulations may only divert resources that are necessary to expand and continue an accessible, door-to-door service that has been available to the disabled population for two years.

Under Section 504 regulations, this strategy does not seem to be acceptable. The possible result seems to be a lessening of the motivation and funding available for paratransit systems.

As RGRTA pointed out, accessible fixed-route systems will not provide true accessibility for those who do not have the mobility to get to the fixed-route stops, so there will still be a demand for paratransit systems to serve the elderly and handicapped. Whether transit organizations can afford both paratransit services and lifts or other accessibility aids on fixed-route systems is an issue yet to be resolved.

The Section 504 regulations also require that paratransit systems themselves contain a sufficient number of specially-equipped vehicles to provide the same service to the handicapped that is provided to the general public. This raises the question of whether an SRT system is accessible to the handicapped if a driver must assist users personally. Such a requirement for personal service will affect work rules and labor agreements.

Meeting the requirements by including a certain number of specially-equipped vehicles in the fleet places a constraint on the scheduling and dispatching methods of the system, and may also affect its productivity.

As districts devise and implement measures to meet these requirements, more experience will become available to aid planners in determining acceptable options.

7.0 THE GROWTH OF PARATRANSIT

The first known DAB system was initiated in the United States about ten years ago. In the subsequent decade, DAB and SRT systems have expanded to over 300 systems. Given the lack of centralization of the market and the limited funds available for this type of transit innovation, this is an impressive growth record. The growth of paratransit in recent years seems to have slowed down somewhat, but there are a number of factors which suggest that this may be a "breather" prior to continued growth.

An examination of the Transportation Improvement Programs (TIP's) from 118 of 245 Metropolitan Planning Organizations (MPO's) revealed that new demand-responsive services are planned in 69 of the MPO regions within the next five years. Twenty-four regions are planning to undertake studies of such systems and, in 89 cases, expansion of existing systems is planned. These plans suggest that the number of systems may increase by at least 100 in the next several years. This is about equal to the number created in the last three years.

Another study (A.M. Voorhees, Reference 258) suggests that demand-responsive systems may be carrying over 16 million passengers per day by 1995. Nationwide estimates of current demand-responsive ridership are difficult to obtain, but extrapolation of systems characteristics data suggests that the current daily ridership is less than 200,000 passengers. The rate of growth projected by this study seems excessive.

Clearly, the recent growth of paratransit systems and programs suggests that there is a growing realization that paratransit has a role to play in the spectrum of transit services. Whether the future growth of these services is slow and steady or becomes accelerated depends on a number of factors, including government action at all levels and the availability of fossil fuels. The one potentially negative factor that may affect this growth is the growing rebellion against taxes and government expenditures, which could reverse the trend.

Based on impressions gained in the development of this Handbooks report and the companion State-of-the-Art report, the authors feel that future paratransit growth will not consist primarily of pure door-to-door dial-a-bus or shared-ride taxi for the general market. Rather, paratransit growth will be primarily in target market services for the elderly and handicapped and in the potentially more productive, limited-doorstop services for the general market, such as deviation from route, deviation from point, many-to-one and many-to-few services.

The reason for this assessment is that a door-to-door service for the elderly and handicapped is the only service that provides real mobility for this market. Hence, if communities truly wish to serve this market, paratransit systems must be seriously considered. For the general market, door-to-door services are relatively expensive on a per-ride basis, and operators will attempt to reduce these costs by installing the more economical limited-doorstop services.

PART 2 CREATING the SYSTEM

1.0 OVERVIEW

The task of creating a paratransit system begins with concept formation and continues until the operation is in place and running smoothly. The process can be split into four stages: Planning, Design, Implementation, and Operation. A fifth stage, Evaluation, may be added to measure and assess system performance and disseminate the assessment results to other communities considering paratransit systems.

This Handbook identifies the five-stage process with the initials PDIOE. The composition of each stage of the process is somewhat arbitrary, and the stages themselves are not mutually exclusive. In creating a paratransit system, a jurisdiction may mix, match, or even ignore functions from each stage. It is not even necessary that each stage be accomplished. In creating smaller systems, a community may proceed directly from preliminary planning to implementation, skipping the detailed design phase; other communities may elect to bypass detailed evaluation procedures. The functions accomplished by a particular community will depend on a number of factors, including community size and population; political climate; current transport modes; perceived transport needs; and the complexity of the proposed system.

Because of the wide variations from community to community and system to system, the five-stage PDIOE process is more important as a framework for discussion than as a prescription for creating a paratransit system. This framework is followed in this section of the guidelines. Separate subsections are devoted to each stage of the process. In each subsection, the functions comprising the stage are outlined, procedures for accomplishing the function are described, and various approaches, suggestions, tools, rules and checklists are provided for the benefit of paratransit planners and operators. Each subsection also contains a list of pitfalls to be avoided in each stage of the PDIOE process. References to more detailed information, either in other sections of the handbook or in other literature, are provided as required.

PDIOE PROCESS CONTENTS

PHASE	BOUNDARIES FROM/TO	FUNCTIONS INCLUDED	TYPICAL DURATION
P PLANNING	FROM: Initial Concept TO: Formal Approval to Proceed w/Design	Identification of needs, objectives, and participation; documentation of existing conditions, institutional issues, and funding sources; preliminary selection of sites, service options, and system configurations; rough estimates of supply, demand, cost and revenues; screening and selection of design alternatives; preparation of design plan and budget.	Between two months and one year. (Average - six months)
D DESIGN	FROM: Political Approval TO: Commitment of Capital Funds	Personnel planning; advance surveying; boundary specification and tour design; detailed demand and fleet size estimates; fare setting; vehicle and communication system selection; design of scheduling and dispatching system; operator selection; facilities design; development of marketing program and staffing plan; detailed scheduling and budgeting.	Between seven weeks and four months. (Average - ten weeks)
I IMPLEMENTATION	FROM: Vehicle Ordering TO: Opening Day	Vehicle and equipment purchasing, personnel hiring; fund applications; regulatory and legal arrangements; staff training; marketing; measurement plans and data collection; pre-testing.	One to six months. (Median - four months)
O OPERATIONS	FROM: Opening Day TO: ?	System debugging, monitoring and modification.	------
E EVALUATION	FROM: Commitment of Capital Funds TO: Steady-State Performance	Evaluation plan preparation; criteria selection; variable definition, measurement planning; population selection; statistical inference; countering threats to validity; ensuring transferability; scheduling measurements; interpreting and reporting results.	------

(Source: SYSTAN)

2.0 PLANNING

The planning phase encompasses all those functions by which a community identifies its transportation requirements, proposes and screens alternatives, undertakes rough feasibility analyses, and obtains political approval for a transportation system. As distinct from the design phase which follows and which covers some of the same ground in more detail, planning activities are typically of a preliminary nature and undertaken by existing organizations using existing data bases.

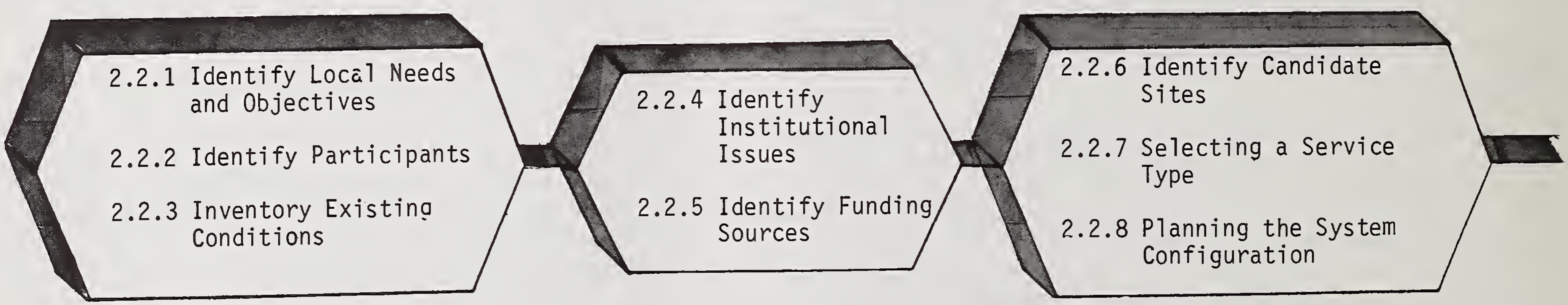
2.1 Overview

2.1.1 Functional Tasks

The planning process begins and ends with decisions by policymakers. In the beginning, they authorize the initiation of the process and, at the end, they select those alternative systems deemed sufficiently attractive for detailed design. The process includes those functions sketched below, from the identification of needs and objectives to the review of alternative systems. There are no set rules governing performance, priorities, or precedence for the indicated tasks. Although each task will generally be accomplished in planning a paratransit system, the level of detail, timing, and even the sequence of the tasks will vary from community to community.

2.1.2 Timing

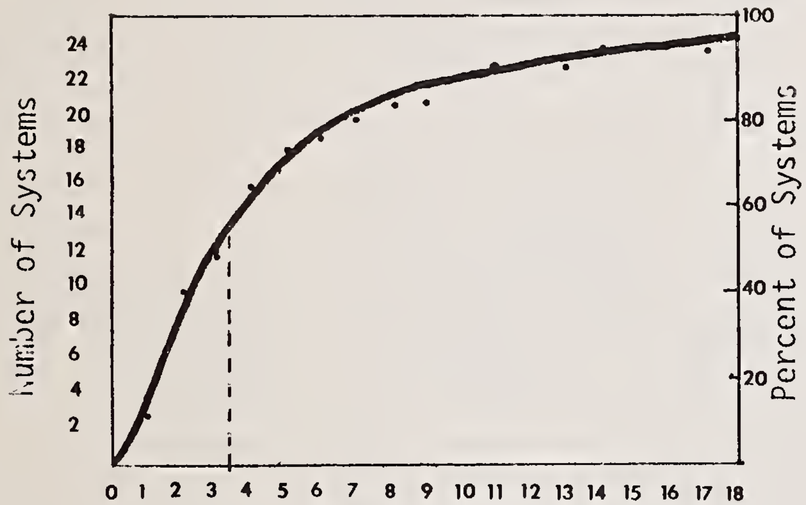
Planners of existing systems report a wide range of experience regarding the amount of time required for the planning process. Of 25 U.S. systems responding to a survey, 72 percent reported that the time between project initiation and a go-ahead decision was less than five months, and 40 percent accomplished the planning task in two months or less (see graph). The average



PLANNING

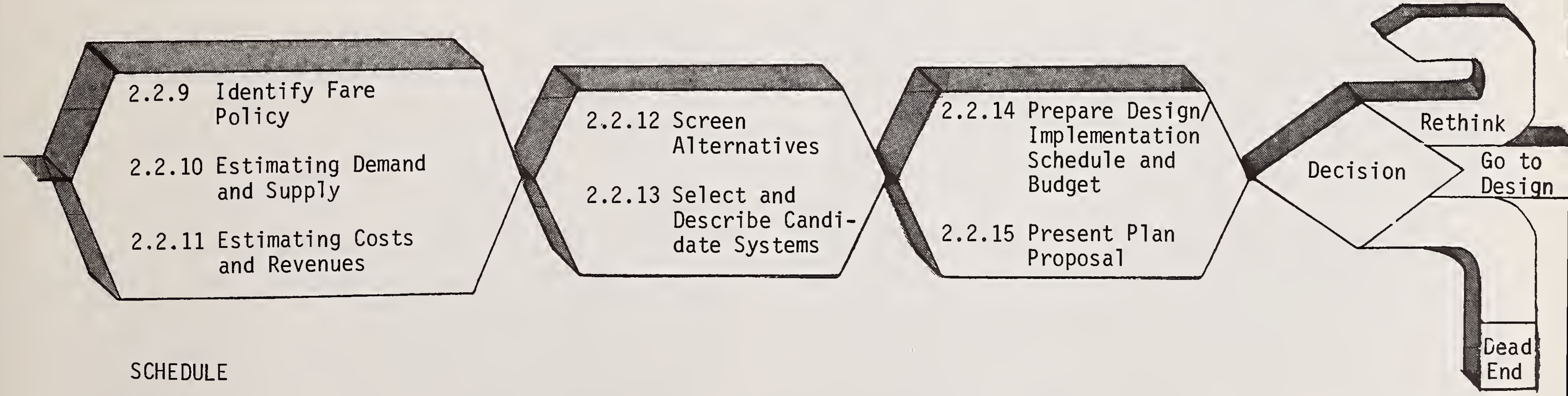
Approximately

LENGTH OF PLANNING PHASE
(Based on 25 DRT Systems)



(Source: SYSTAN)

time span reported was five months. Experience with Canadian systems reflects a range of three to ten months, with an average of seven months (Reference 4). The variation from community to community can be traced to several factors, including the local political climate, the number of decisions required, the complexity of the proposed system, the availability of planning expertise, the size and population of the service area, the existing transportation infrastructure, and the amount of community pressure applied. Shorter planning periods were reported by communities in states such as Michigan, which supports community planners in a number of ways. In the absence of such support, three to four months represent a good approximation of the planning time needed.



SCHEDULE

3-4 Months

2.1.3 Analytic Approaches

Planning approaches vary with community needs, political objectives, existing transportation resources, financial resources, institutional constraints, and the demographic and geographic setting. These factors not only affect the plans, but also determine what type of planning process will be followed.

At one extreme is a "seat-of-the-pants" approach in which decisions are made with little or no analysis. This process can be characterized as "putting buses out and seeing who rides." At the other end of the spectrum is the careful analytical approach using substantial amounts of empirical information and quantitative models for estimating the relationships among supply, demand and service levels. The entire range of approaches have their place; the selection of the appropriate approach for any given situation is an art guided by the specific needs and constraints of the situation. The flexible nature of demand-responsive systems generally argues for simpler, rather than more complex, planning approaches.

The starting point of the planning process will also depend on local concerns. If financial resources severely limit the supply of buses available, the planner begins with a different set of assumptions than he would if given a mandate to provide minimum service to a specific area or market segment, regardless of cost.

Planners of existing systems have relied heavily on rules of thumb and empirical evidence from other operations in accomplishing the required planning tasks. In cases where more analysis is required because the proposed systems are significantly different from existing systems or subsequent modification is difficult, some form of explicit modeling may be useful, typically at an aggregate rather than a detailed level. Subsequent subsections discuss the use of available rules of thumb, operating experience, and simple models in accomplishing the planning tasks diagrammed on the preceding page.

2.1.4 Data Requirements and Sources

Published documents and past studies, although often out of date and incomplete, provide an available and useful resource that should be carefully mined before undertaking any new data collection. Records of past requirements can be useful in postulating current needs; records of past mistakes can help to avoid costly repetition.

Some of the data that are available for almost all urban areas are listed in the exhibit. The census data are the most comprehensive and reliable of any source. Although they tend to be out of date, they contain valuable information and should not be overlooked. Other sources, such as the <u>National Transportation Study</u> (NTS) are also helpful, but tend to be less comprehensive than the census. Local traffic data should give a fairly current picture of traffic volume, but say nothing about the trips that this volume represents. Transit records give patronage (fares) by route, but rarely include trip data. These data sources will provide useful information about the setting and about existing movement patterns.

Trip data information might exist in previous local transportation studies. Somewhere deep in the files, there may be a comprehensive planning study that is largely highway-based but that contains trip data as estimated by the UTPS battery of computer programs or other computer procedures. These data are based on traffic zones which tend to be quite small. A city of 200,000 residents may have 500 traffic zones; a city of 2,000,000 may have 1,500. As a result, the trip data tend to be voluminous and need to be reduced and compressed to fit the new structure. These data will best describe long trips for which demand-responsive systems can provide collection and distribution service. Data on short trips are distorted by the assumption that all zonal activity is focused at the zone centroid; it may be more accurate to complete these data from traffic volume information. In general, data on the origins and destinations of short trips should be viewed with caution.

SOURCES AND TYPES OF AVAILABLE DATA

Data Describing General Urban Setting

Demographic Data	Source
Population	Census
Income Distribution	"
Employment Distribution	"
CBD Employment	"
Land Area	Atlas
Climate	"
Major Terrain Features	"
Settlement Form	City Plan
Crime Rate	Census

Institutional Data	
State, regional and local transportation authorities	Local Charters
Funding Channels	Local Records

Transportation Systems Data	Source
Journey to Work (Mode & Distance	Census
Miles of Highway and Transit Routes	Local Studies or 1974 NTS Update
Average Trip Length and Time	"
Car Occupancy	"
VMT/Capita	"
Transit Ridership/Capita	"
Percent of Population Within 1/4 Mile of Bus Service	"
Average Bus System Headways	"
Passenger-Miles/Seat Mile	"
Average Bus Fares	"
Accident History	Police Records
Transportation Institutional Structure	Local Study

Data Describing Service Area

Data	Source
Traffic Flow Densities on Streets & Through Cordons	City Traffic Engineer
Patronage History on Transit Routes	Bus Operating Records
Accident History on Streets	Police Records
Description of Traffic Control Systems	City Traffic Engineer

DATA AVAILABLE THROUGH SURVEYS

Information Requirements	Data Sources
Patron location, trip characteristics	Agency Surveys
Passenger volume	Operator Surveys
Passenger attitude	On-Board Surveys
Verification of on-board survey results	Case Studies
Identify eligible persons and their reasons for not using the service	Non-User Survey

(Source: SYSTAN)

Studies will likely be available that address special aspects of transportation--e.g., public transit, new freeway construction. These will also prove useful, but be aware that often special studies are undertaken to prove a point. They may be guilty of biasing the data. Nonetheless, these reports contain useful information. Some additional trip data may be available in studies of transportation needs of social service agency patrons. This information is essential to planning services for target groups and is generally in a form that will permit manual analysis. Carpool matching data are also useful if they are coded by residence and employment zones. These data are biased but they often describe a large number of trips to work.

Past surveys also contain useful information. They should be reviewed and catalogued so that their results can be used. The facing exhibit lists several types of surveys and the information that they are likely to contain.

The cumulative set of past surveys may well leave gaping holes in the desired transportation planning data. Do not attempt to fill these voids at this time! Surveys are costly and time consuming. Before beginning a survey, a specific objective should be clear. Broad surveys tend to collect large amounts of data that are never used.

The product of the data analysis should be a complete list of available data together with limitations, biases, and restrictions on use. To this, known data requirements can be added. Actual data collection should not generally be undertaken at this time; as work proceeds through the analytical tasks, exact data needs and the shortcomings of existing data can be identified and data collection programs can be undertaken to fill the gaps.

2.2 Procedures

2.2.1 Identify Local Needs and Objectives

The first step in planning any transit system is to address the three questions: What Are We Trying to Do? For Whom? and Why? A statement of objectives attempts to document the answers to the first of these questions by relating the aims of the system to the needs identified in addressing the second and third questions.

(A) Identify Needs

The first step in identifying transportation needs is to assess the adequacy of the service provided by any existing transit systems. How well do the existing systems serve the various groups and geographic areas within the community, given the amount of time and money expended? In communities that rely solely on the automobile, the question of whether this reliance is desirable or adequate should be addressed.

One approach to identifying needs is to look at the perspectives and concerns of different sectors of the community: the riders, operators, and community at large. The accompanying exhibit from Reference 41. lists some of the factors each sector uses to rate transportation. These factors can be used as a checklist in identifying satisfactory and unsatisfactory aspects of the existing transportation network.

The identification of transportation needs can come from a variety of sources: surveys, transportation studies, community meetings, or the appearance at City Hall of a citizens' action group with a list of requirements. The information needed may already exist, or the planner may have to initiate its development.

FACTORS USED TO RATE TRANSPORTATION

Passenger	Operator	Community
Availability	Area Coverage	Passenger Attraction
Punctuality	Frequency	Long Range Impact
Speed-Travel Time	Speed	Environmental/Energy Aspect
User Cost	Reliability	Economic Efficiency
Comfort	Cost	
Security	Capacity	
Convenience	Safety	
	Side Effects	
	Passenger Attraction	

(Source: Hart, Reference 41)

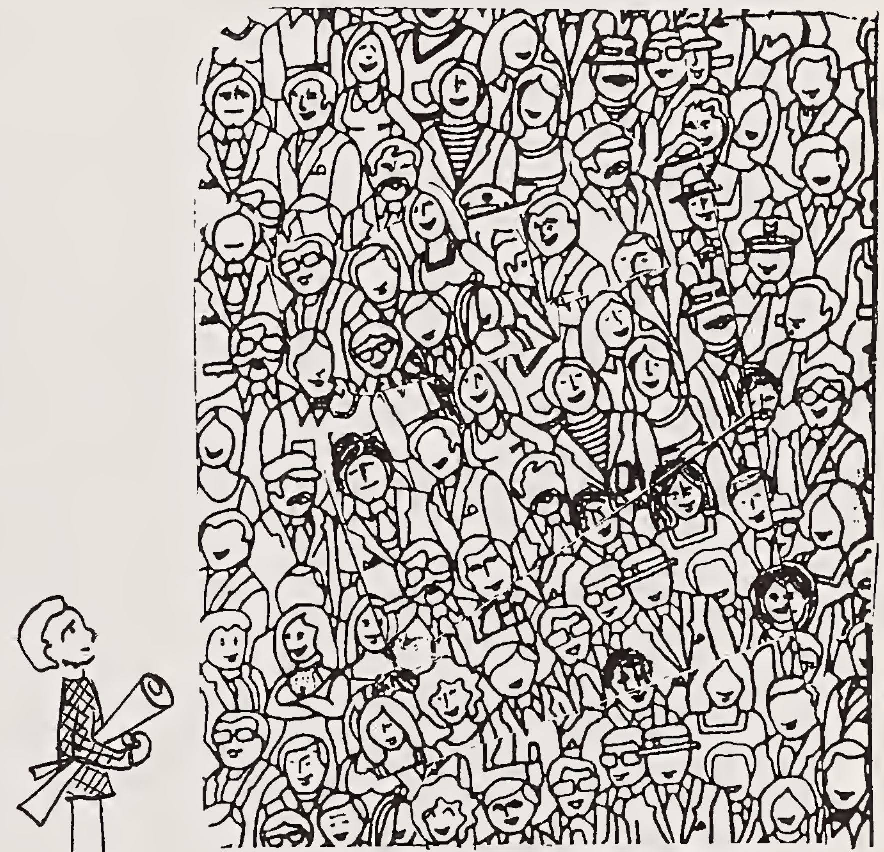
Additional steps in identifying transportation needs might include:

- Identification of groups with special transportation needs and their travel requirements (handicapped, transit-dependent, elderly).
- Identification of general travel patterns during peak and off-peak hours and specification of major trip generators and attractors.
- Identification of bottlenecks in the existing transportation network.

If needs are not readily apparent, a mechanism should be developed for soliciting input from the community. (See Section 2.2.2(C) for potential mechanisms.) Needs and deficiencies are not always obvious. For example, a meeting in a low-income area of Menlo Park, California revealed that, while the bus system served the area, it was inadequate for a substantial portion of workers, who ended up riding for 1½ hours one-way with transfers to reach a large employment site a few miles away.

Task forces or advisory committees composed of different community sectors have been used successfully not only to identify existing transportation needs and deficiencies, but also to offer continuing community input during the subsequent development of a system.

Any attempt to define the transportation needs of target market groups (e.g., elderly and handicapped) calls for representation from a variety of special interests, including citizens from elderly and handicapped associations; social service agencies; providers of specialized transportation; taxi operators; etc.



If you don't know, ask.

P

2.2.1(C)
Communication Channels

(B) Develop Objectives

Transportation objectives should address identified needs and may reflect broad community goals or immediate shortcomings in the existing system. Most objectives can be classified in one of the five categories:

(1) Accessibility;

(2) Mobility;

(3) Safety;

(4) Environmental quality; and

(5) Cost. (Reference 41)

The objectives of an experimental or demonstration project may also reflect a desire to assess and document the impact of a specific innovation. Such experimental projects typically impose greater data-gathering requirements than more permanent projects, since there is a need not only to monitor performance and cost for purposes of project control, but also to draw inferences regarding the cause of measured impacts that can be interpreted by other areas.

(i) Sample Objectives

In the past, a wide variety of objectives have been cited by communities introducing paratransit systems. A summary of these objectives are tabulated in the accompanying list. As a specific example, the City of Fairfield, California developed a list of objectives designed to incorporate the system within the community setting. They used a study of needs, a transit options report, and meetings with an advisory committee to identify the following community goals:

PARATRANSIT GOALS AND OBJECTIVES CITED BY EXISTING PARATRANSIT SYSTEMS

Social Objectives

- Alleviate necessity of chauffeuring non-drivers
- Increase mobility of transit dependent
- Reduce congestion, pollution, energy consumption, noise and land area needed for parking
- Reduce multiple car ownership
- Increase utilization of social, recreational and medical services
- Increase employment opportunities

Transit System Objectives

- Provide expanded service into areas not well-covered by conventional transit (transit equity)
- Replace marginal bus routes
- Feed express buses or other fixed-route systems
- Increase ridership on express buses or other fixed-route systems
- Provide more efficient off-peak service
- Identify promising patterns for conventional fixed-route service
- Improve overall system efficiency and productivity
- Provide additional peak-period capacity
- Provide higher quality service (i.e. more flexible, pleasant, reliable and convenient)
- Minimize capital investment
- Test use of new equipment and techniques
- Achieve and maintain low operating subsidy
- Provide greater personal security on transit

(Source: SYSTAN)

- Provide a viable transportation system within the City of Fairfield;
- Serve the special needs of the transit-dependent;
- Provide a convenient and viable alternative to the private automobile;
- Support the Fairfield business community;
- Support the land-use element;
- Provide the best service possible at the lowest price;
- Provide the first element of a regional transportation system; and
- Provide assistance to other City services.

(ii) Identifying Measurable Objectives. The task of listing transportation objectives is not as simple as it sounds. As one writer has observed,

> "Experience in many studies has shown the difficulty in developing a set of value statements which can be agreed upon by all members of the community, yet are specific enough for analytical use in the evaluation of alternatives. Little public objection can be raised against a transportation goal promising to provide mobility for the carless population of the area--the poor, disabled, elderly and young--or one which provides a viable option to the private automobile in order to enhance individual mobility." (Reference 53) But goals such as these are vague and unmeasurable. How much mobility is to be provided the carless population? What is considered to be a "viable option" to the private automobile? Bus service every ten minutes, every hour? (Reference 41 .

To the extent possible, an attempt should be made to develop measurable objectives. Where general terms such as "mobility" or "accessibility" are used, they should be accompanied by specific, measurable examples amenable to quantitative evaluation. Detailed procedures for defining and assessing quantifiable objectives are discussed in the Evaluation section (Section 6).

(iii) Identifying Realistic Objectives. Clearly, stated system objectives should not only be measurable, but should also bear a realistic relationship to the anticipated system impacts. It is important to form an appreciation of the likely impacts of integrated paratransit systems early in the planning process to avoid misunderstanding and problems in later stages. It appears that the major impacts of integrated paratransit services are likely to be:

- Improved mobility for people permanently or temporarily without access to private automobiles or high-quality transit service;
- Reduced total cost of transportation for commuters, taxi users, and others; and
- Reduced congestion and parking requirements at individual employment or activity centers. (Eldon Ziegler, Reference 31)

Noticeably missing from this list of major impacts are the important concerns of energy and environmental projection. Paratransit offers only a marginal solution to energy and environmental problems, although it fills a role as an element of our existing transportation systems and provides an alternative to the automobile in the event of a future energy crisis.

6.2
Evaluation Procedures

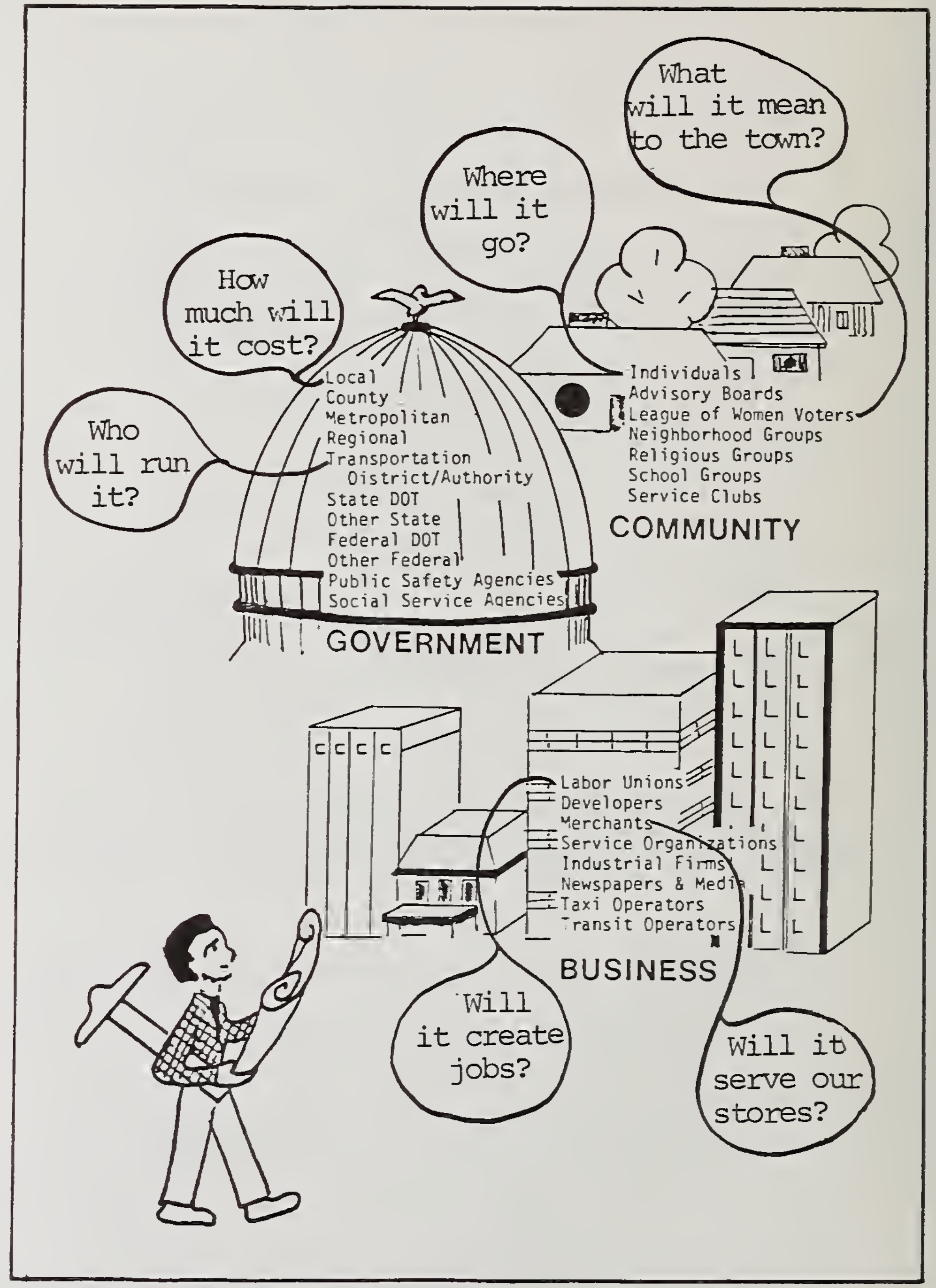
2.2.2 Identify Participants in Planning

The objective of this step in planning is to identify the principal groups involved in the transportation decisionmaking process. These groups include representatives of the business community, government, and citizen groups. In preliminary planning, representatives of these groups need to be included in discussions of proposed plans; the role and composition of advisory groups must be settled, mechanisms for soliciting community input must be established and a program for informing the public of proposed plans must be developed. Community support is both a matter of participation in the planning process and of public relations. Experience indicates that if a community perceives a service as "good," decisionmakers are safe to move ahead with plans even if they appear to be costly. But without community support, the most promising system is likely to flounder.

The initial decision to approve implementation of demand-responsive transportation is inherently political. Except for the smallest-scale services, which can be instituted unilaterally by the operator, most services require the participation of a number of decisionmakers. The key dimensions of a particular demand-responsive service--where it will be, who will run it, who will be served--will be the product of negotiations among a variety of interested groups.

This aspect of the preliminary planning stage, as a process of negotiation among a variety of interests, prompts a new role for the planner: that of a coordination of divergent viewpoints and objectives. With this new role in mind, the planner should undertake the following activities early in the planning process:

- Identify the planning organization and its responsibilities;
- Identify concerned groups; and
- Create lines of communication.



Source: SYSTAN

(A) Identify Planning Organization and Responsibilities

The purpose of this step is to identify the other players in the planning game. In the process of sketch planning, it is important to sort out the various individuals with these responsibilities related to system development. These responsibilities may relate to:

- Policy;
- Coordination;
- Regulation;
- Approval; or
- Expert advice.

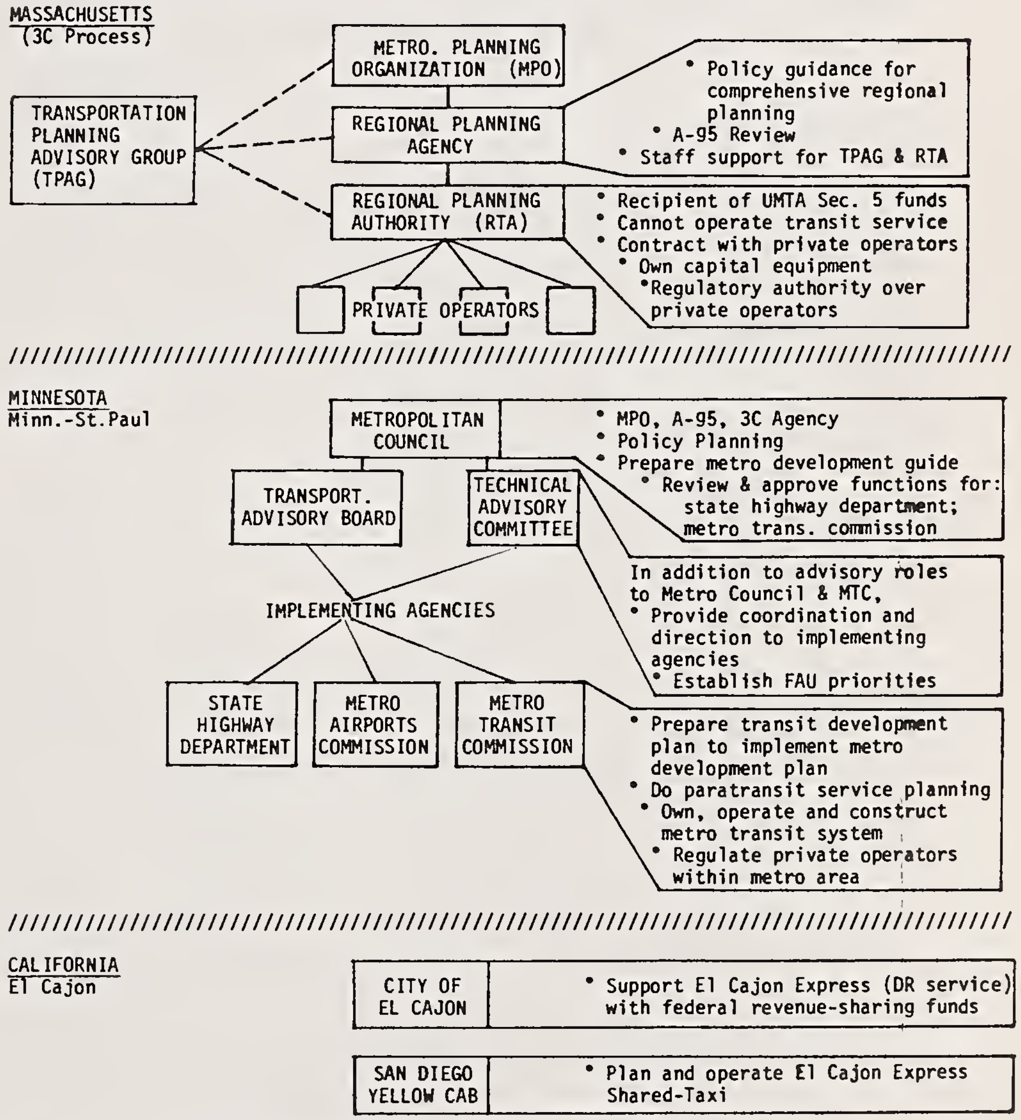
Identify the organizations, define their role and their method of interaction with the project. For example, a hierarchy of approval channels may exist (e.g., transit district, metropolitan planning organization, etc.) that must be navigated before project developement can begin. Such channels are often associated with project funding. (See Section 2.2.5 for requirements attached to receipt of funding.)

It may be useful to draw an organization chart of the institutions and groups involved in the project to show their relationship to one another and to the planning process.

There is considerable variety in existing organizational planning arrangements. The accompanying exhibit illustrates a range of typical structures, from the complex Massachusetts 3c planning process (UMTA's Continuing, Cooperative and Comprehensive planning process, required for urban areas to receive federal funds) to the simple arrangements made between a city and a cab company in California.

With efforts being made to coordinate and integrate paratransit with other forms of public transportation, planners will also have to assure a voice for these services in planning discussions.

TYPICAL INSTITUTIONAL STRUCTURES FOR PLANNING SYSTEMS



(Source: Developed for Paratransit Workshop, October 1977)

2.2.5
Funding Sources

P 2.2.2

Information from documentation of existing systems suggests that most planning has been done within simple organizational structures. Of the 39 systems reporting (see exhibit), the responsible planning organizations cited most often were local transit authorities or districts (15) and cities (11). In 26 cases, the authority and the planner were one and the same. In Michigan, several communities noted that their planning guidance came from the State DART program. For the 33 SRT operations, 64% were systems sponsored by a city and operated by a cab company. Available documentation revealed that the planning process for these systems was simply a matter of identifying needs and funding sources and setting objectives, and then handing over the system to the experienced cab companies for operation.

SAMPLE OF ORGANIZATIONAL ARRANGEMENTS FOR CREATING THE SYSTEM (97 SYSTEMS)

	Functions			
Organizations	Sponsor	Authority	Planner	Operator
City	54	44	11	19
County	13	12	5	10
Transit Authority	19	25	15	9
Transit Company		1	1	14
Cab Company	3		3	33
Management Firm			1	6
Social Service Agency	3		3	6
TOTAL:*	92	82	39	97

Note --
FUNCTIONS:
Sponsor: Political decision-making body.
Authority: Transportation authority responsible to sponsor.
Planner: Consultant, authority or operator.
Operator: Runs service on day-to-day basis.

Entries = Number of responses from individual systems.

*Not all systems provided complete information, so numbers do not total 97.

(Source: SYSTAN)

(B) Identify Participating Groups

The introduction of a new system will have some appreciable effect on the community. The magnitude of this impact will depend on the magnitude of the change. During the early planning stage, it is important to identify all persons or organizations that might be affected by the introduction of a new service. In addition to the groups within formal planning organizations, interested parties might include:

- Policymakers;
- Existing operators;
- Labor organizations;
- Community residents;
- Community-based organizations and employment centers; and
- (for target market systems) Social service organizations, senior citizens' groups, target market representatives, etc.

The accompanying exhibit suggests a number of groups that could be concerned about a new transit service, and points out some of the issues they might raise. The earlier these groups are identified and included in planning discussions, the sooner the planners will perceive the relative ease or difficulty of introducing the system into the community. Early group discussions will provide an opportunity to learn about those areas of concern which may be open to compromise, and may lay the groundwork for working out the compromise.

INFORMATION NEEDS AND INDICATORS

Group	Information Needs	Indicators
Local		
Politicians	Financial considerations	Annual capital cost estimates, operating cost estimates, revenue (ridership), funding sources, funding ability
	Goal satisfaction (evaluation)	Transportation needs, community impacts including interest groups, economic viability, and environmental impacts; effective use of existing facilities, land use implications
	Other government interface	Relation to regional (or higher) plans, budgets, and the like
	Risk-confidence	Cost of "failure", criterion of success or failure, ease of experimentation including financial, institutional, and technological flexibility and adaptability, lead time, staging, or other implementation problems
	Institutional factors	Labor union charter, legislation for new institutions, other transportation institutions or charters
	Awareness-differentiation of system availability	Attributes, taxonomy
Operators	Competitive impacts	Impact on competition, dependence on competition
	Operational requirements	Manpower, vehicle, and management needs; marketing information system; implication of new technology skill levels
	Financial considerations	Operating costs, risk with respect to reliability
	Institutional constraints	Labor input, productivity, regulatory constraints
Consumer*		Travel time, cost, convenience, comfort, safety, reliability, public image, perception
Resident°		Environmental intrusion, aesthetics, noise, nonuser safety costs (taxes)
Developer	Land use implications	Land use changes, new large activity centers that can "design in" a new technology, land use controls
	Profit maximization	Increasing or decreasing property value
State		
Department of Transportation	Resource allocation	Geographical allocation of transportation investment dollars, modal allocation
	Transferability	Use in other cities
Other	Financial requirements	Revenue alternatives
	Economic impacts	Employment
	Goals and priorities	Alternatives
Federal		
Department of Transportation	Funding requirements	National funding demand—capital intensive or noncapital intensive; system roles
	Transferability	Use in other cities and states, national potential benefit
	Development and implementation strategies	Research and development decisions, staging, and methodology; design of prototype development and demonstration projects, including site selection
	Technology assessment	Program decisions
	Distribution of funds	
Other	Resource requirements	Energy, raw materials, land
	Economic impacts	Employment, international trade, secondary effects
	National goals and priorities	Relationships and modification
Manufacturing	Profitability	Market forecasts, capital cost, staging alternatives, funding sources
	Risk assessment	Development funding, demonstrations

*Two types, including one who actually uses new system and one who uses competition that performs better or worse because of new system

°One who is impacted by nontransportation characteristics of system

(Source: HRB Special Report No. 143, Reference 58)

(C) Lines of Communication

Early communication between planners and concerned groups is needed to:

- "Test the winds" about the feasibility of launching the project within the community;

- Identify possible conflicts or issues needing resolution; and

- Create an opportunity to broaden community support.

Communication channels (adopted from Reference 62) open for use include:

<u>Information distribution</u> using all primary communications media (radio, newspaper, television) and a broad spectrum of tools, including press releases, newsletters, brochures, reports, speeches, personal interview, plan summaries, slides, films, and press conferences.

<u>Information collection</u> via surveys (questionnaires distributed at public meetings, public opinion surveys, and other sources.

<u>Interactive approaches</u>, including public forums and hearings, seminars, and workshops.

<u>FRONT AND BACK OF A COMMUNITY BROCHURE</u>

<u>FROM SEATTLE, WASHINGTON</u>

MetroTRANSITion Public Meetings

October 6 7:30 p.m.	Bellevue Library Conference Room 11501 Main Street, Bellevue
October 7 7:30 p.m.	Seattle Central Community College Room 1110 Broadway and Pine, Seattle
October 13 12:00 noon	Seattle Public Library Auditorium 4th and Madison, Seattle
October 18 7:30 p.m.	North Seattle Community College Board Room (2161A) 9600 College Way N., Seattle
October 19 7:30 p.m.	Renton Public Library Multi Purpose Room 100 Cedar River St., Renton

If you would like more information about the meetings or if you would like to receive a booklet explaining the choices more thoroughly, please call Metro Community Involvement, 447-6762, or write us at 600 First Avenue, Seattle, Washington 98104.

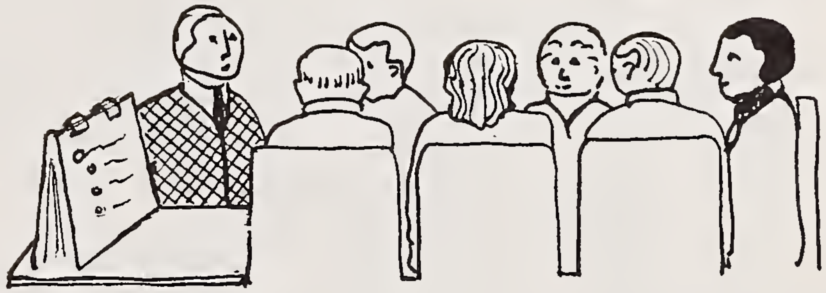
METRO
Community Involvement
447-6762

Choosing a transit future -it's up to us.

METRO

One popular mechanism used in the development of systems is the advisory group. These groups need to be formed with care. Some suggestions for an effective committee include:

- Good representation of different community sectors; for target market systems, representation may include social service agencies, senior citizens' groups, and other special groups.
- Active and informed members.
- Clear and open communication between planners and the advisory group.
- Use of technical assistance when needed.
- Wide dissemination of information and results of committee work to planners, community and other involved groups.



One innovative approach to guaranteeing active committee involvement took place in Virginia: Any interested person was allowed to join the advisory group, but they were allowed to remain on the committee only if they attended meetings faithfully.

Whatever the forum for discussion, it is important to publicize all official processes and make sure that the associated time frame is widely understood. Information sources should be widely publicized so that people know both how and when to participate. One example of a communication program that is adaptable to paratransit planning (adapted from information prepared by the San Francisco City Planning Department (Reference 57)) is shown on the next page.

P

2.2.2

ESTIMATED TIME REQUIRED FOR EACH STEP

CITY ACTIONS

COMMUNITY ACTIONS

START

LOCAL ORGANIZING (Community)
1. FORM ADVISORY GROUP
2. DEFINE STUDY AREA
3. LIST COMMUNITY & TRANSPORTATION OBJ.
4. REQUEST ASSISTANCE FROM CITY

13 - 21 WEEKS

PLAN DEVELOPMENT (City)
1. DEFINE PROBLEMS WITH DATA, SURVEYS OF EXISTING CONDITIONS
2. SECURE INPUT FROM EXISTING OPERATORS, LABOR etc.
3. WORK WITH COMMUNITY TO PREPARE SKETCH PLAN
4. EVALUATE ALTERNATIVES
5. PREPARE PRELIMINARY COST ESTIMATES
6. REVIEW BUDGET FOR FUNDING

PLAN DEVELOPMENT (Community)
1. REVIEW DATA, OBJECTIVES
2. EVALUATE PROBLEMS AND POSSIBLE SOLUTIONS
3. INFORM RESIDENTS ABOUT PLAN STUDY
4. COLLECT RESIDENTS' IDEAS AND REACTIONS
5. WORK WITH CITY STAFF TO PREPARE ACCEPTABLE SCHEMATIC PLAN

4 - 6 WEEKS

REVIEW (City)
1. CITY ENGINEER
2. DIRECTOR OF CITY PLANNING
3. PROJECT CONSIDERED FOR CAPITAL IMPROVEMENT PROGRAMMING
4. ADJUSTMENTS TO PLAN, IF REQUIRED

IF ADJUSTMENTS REQUIRED, WORK WITH CITY DEPARTMENTS TO ARRIVE AT ACCEPTABLE SOLUTIONS (Community)

INFORM RESIDENTS (Community)
1. NEWSLETTERS, MEETINGS, BLOCK PARTIES, ETC.
2. PETITIONS
3. ENCOURAGE ATTENDANCE AT HEARINGS

2 - 4 WEEKS

DIRECTOR'S HEARING
NOTICES POSTED & PROJECT SUMMARIES PREPARED

ATTEND HEARING

15 - 18 WEEKS

DEPARTMENTAL ACTION
1. SCHEMATIC PLANS APPROVED BY CITY ENGINEER
2. DETAILED COST ESTIMATE
3. MASTER PLAN REFERRAL
4. ENVIRONMENTAL IMPACT ASSESSED

CITY PLANNING COMMISSION APPROVAL

ATTEND COMMISSION MEETING

10 WEEKS

BOARD OF SUPERVISORS
1. FIRE, SAFETY, POLICE COMMITTEE
2. STREETS AND TRANSPORTATION COMMITTEE
3. FINANCE COMMITTEE
4. BOARD OF SUPERVISORS APPROVAL

MAYOR
MAYOR APPROVAL

CONTINUING COMMUNITY SUPPORT
1. FOLLOW-UP ON OFFICIAL ACTIONS
2. MAINTAIN LOCAL INTEREST & SUPPORT
3. ATTEND SUPERVISORS' HEARINGS
4. WRITE LETTERS, ETC.

18 - 22 WEEKS

IMPLEMENTATION
1. DETAIL DESIGN
2. PLANS & SPECIFICATIONS
3. ADVERTISE FOR AND RECEIVE BIDS
4. CONTRACT AWARDED

CONSULT ON DETAILS: routes, equipments, etc

ENJOY!

2.2.3 Inventory Existing Conditions

An overview of existing conditions in the proposed service area forms a valuable tool that can serve as a basis for assessing some of the impacts a future system might have on the community. Components of the inventory include:

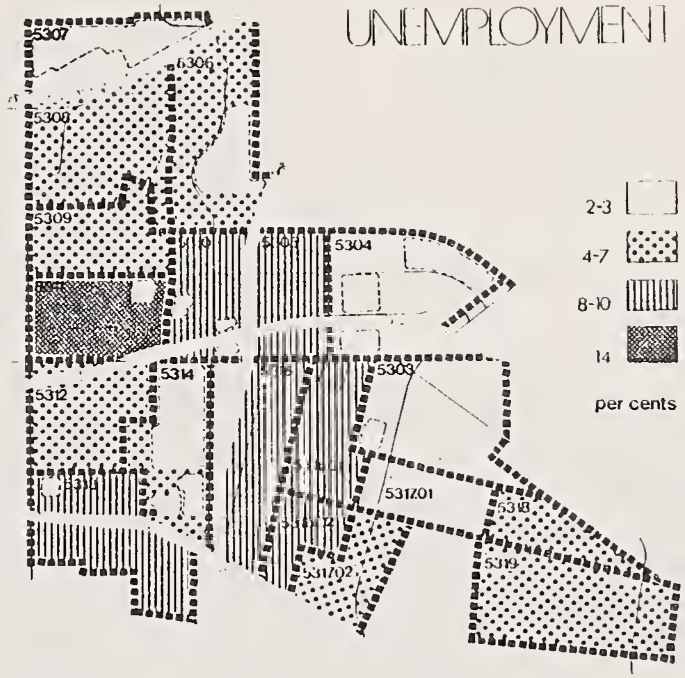
- o Population characteristics;
- o Topographic features;
- o Man-made features; and
- o Existing transportation services.

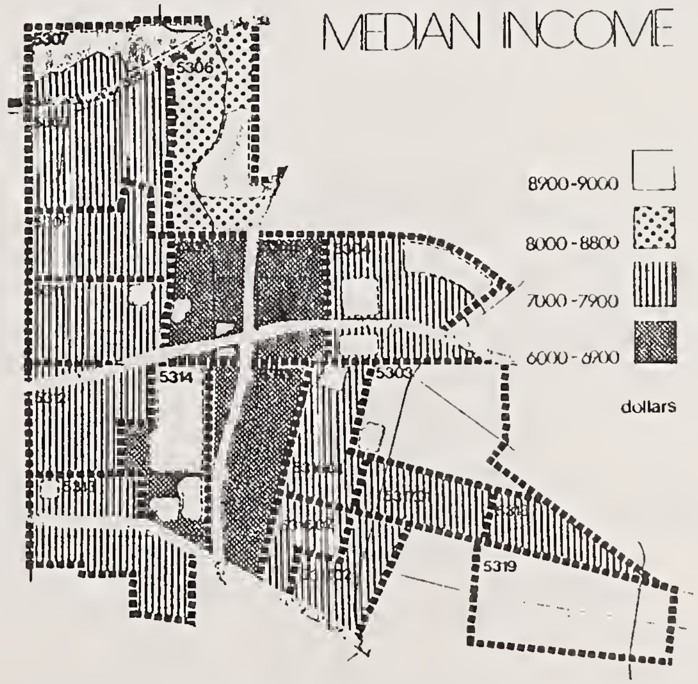
This task acts as a bridge between the initial collection of population data and the planning tasks involving service area selection (Section 2.2.7), configuration mapping (Section 2.2.8), and demand estimation (Section 2.2.10). Again, it should be emphasized that planners should rely exclusively on existing data. These data may be reorganized, however, in a manner suitable for use in the planning process. This section includes examples of data presentations used to build a picture of community conditions and needs.

(A) Population Characteristics

Knowing where people live and work will help identify potential tripmakers and their travel needs. These data can be broken down into smaller groupings for consideration in transportation planning: workers with or without cars, elderly, young (school age), low income, housewives, handicapped -- all those who have different transit needs.

Basic information about a community's population should include:





(Source: Barrio Planners, Reference 32)

2.2.7 for selecting a service type
2.2.8 for system configuration planning
2.2.10 for estimating demand

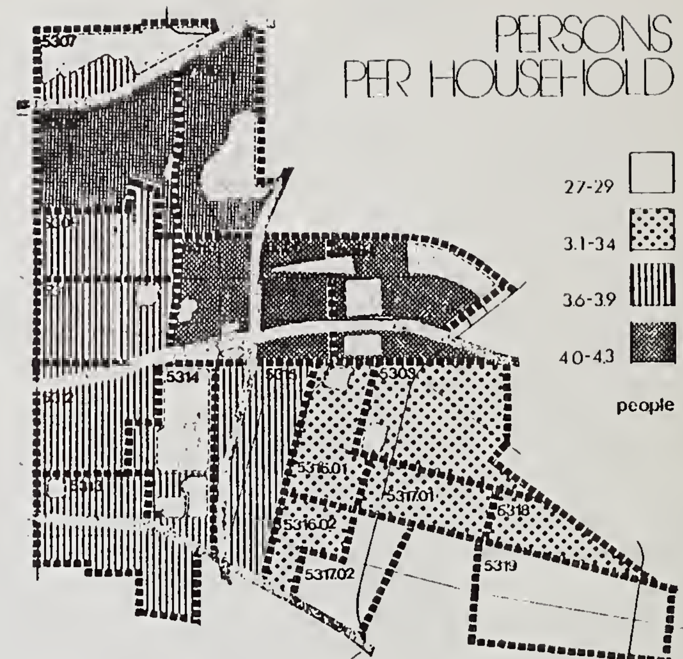
- Trip purpose;
- Trip patterns;
- Distance;
- Time;
- Frequency; and
- Mode.

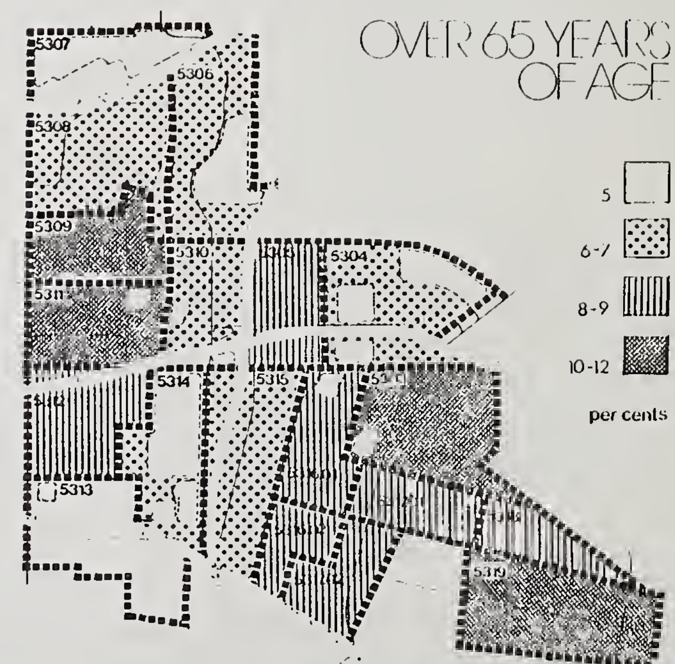
The accompanying graphics (Reference 32) present the mapping of some of these data from census tract information for a Los Angeles, California community. These maps can be a useful way to highlight key factors in planning, especially when presenting community facts to others. As an example, one planner working on a transportation project for low-income workers made his central remarks clear to his audience by using a mapping technique. On the map, he circled the low-income housing areas and then the employment centers, which were some distance away. Then, adding the transit routes, he could demonstrate how inadequate the existing transit system was in providing potential workers with a way to reach employment sites.

(B) Topographic Features

The natural features of the community, or the "lay of the land," need to be identified for consideration in transit planning. This assessment records all elevations and the degree of slope for identifying barriers to passage or difficulties in climbing steep grades. Traffic engineers at the community level should be able to supply this information.

The climate of the community should be considered for its impact on vehicle use and operation. Such considera-





(Source: Barrio Planners, Inc., Reference 32)

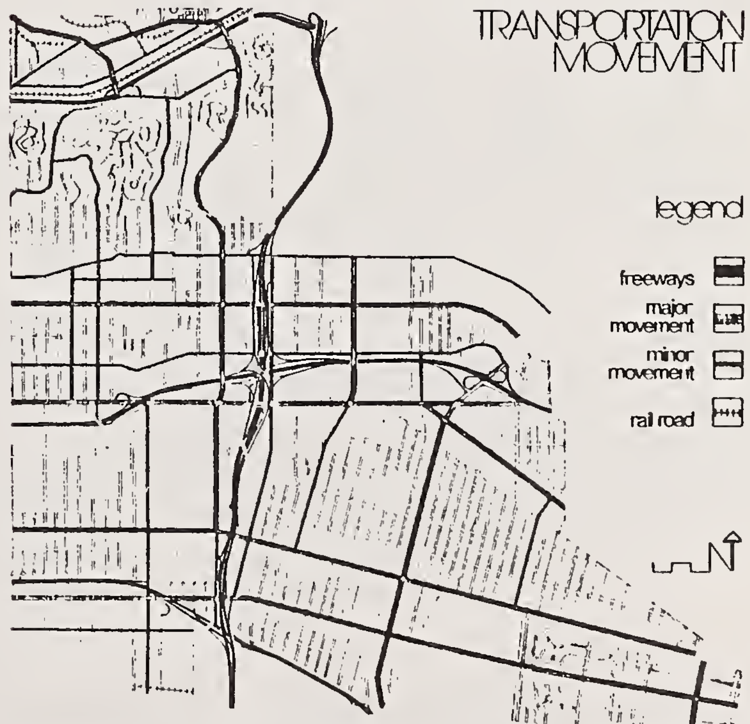
tions as air conditioning or shelters may be dictated by the local weather conditions. Climate may also be a factor in the delivery of door-to-door service. What effect on system operation would a snowstorm have on the pick-up and delivery of people on neighborhood streets?

(C) Man-Made Features

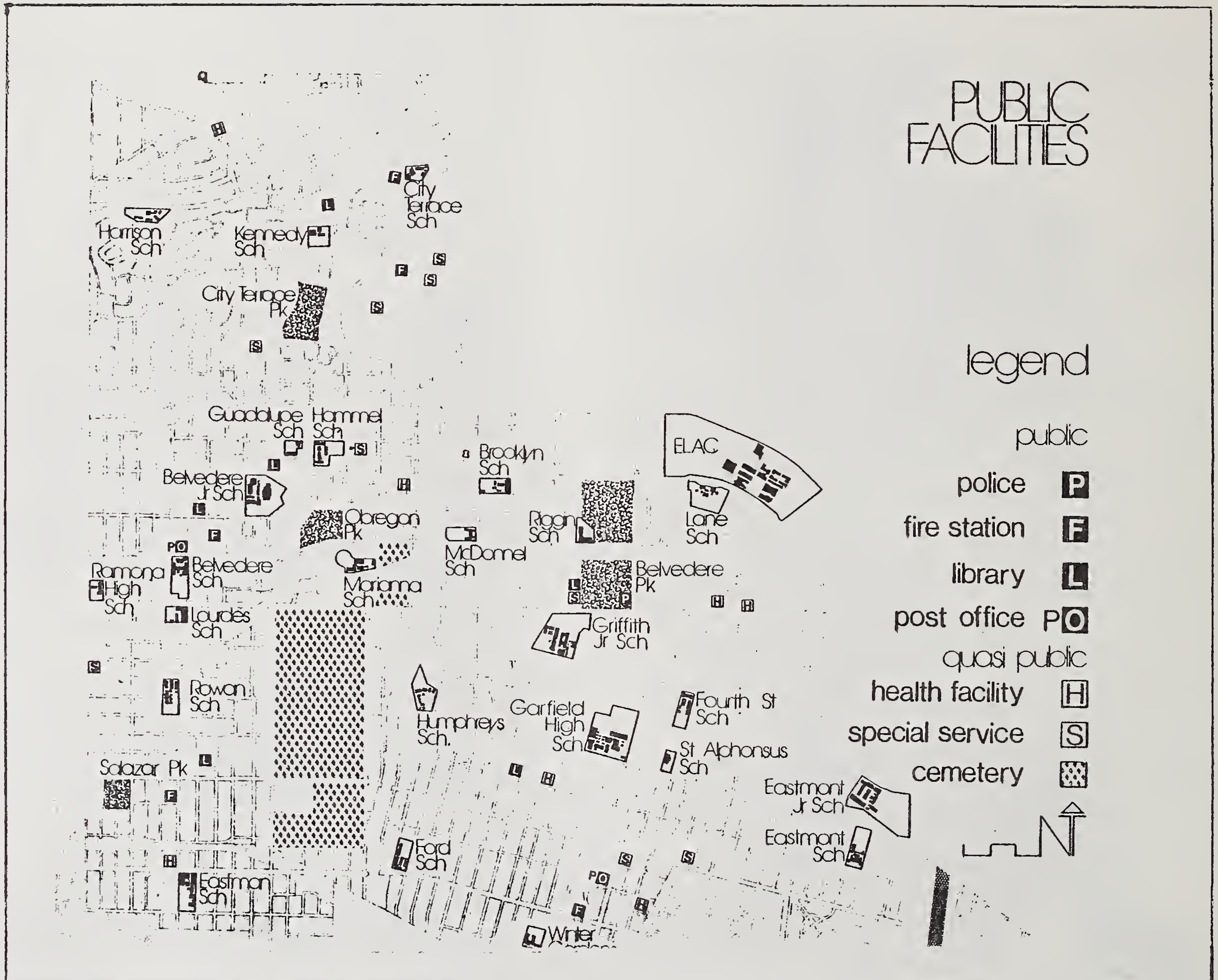
An assessment should be made of physical features, such as the street network and the major attractors and generators of traffic. The task at hand is to identify factors for consideration in planning a system and any limitations or constraints the network may impose.

The street network should be mapped, with traffic bottlenecks, road capacity, and any proposed or scheduled changes noted. The width and turnaround configuration as well as road conditions need to be considered also. There are a variety of turning radii available, depending on wheelbase and depth of wheel wells in the front of the vehicle. If there are many tight turns, a shorter wheelbase with the tightest turning radius (i.e., the smallest number of feet in the radius) may be needed. In addition, rough or unpaved streets would require heavy-duty suspension systems even for light-duty mileage (under 200 miles per day). The clearance of chassis elements over rough roads may also create a maintenance and replacement problem.

The accompanying maps exhibit the street network, and transportation movement for one community. In addition, conglomerate maps were developed to indicate the major centers of community activity and public facilities (see exhibit on next page) which exist within the area and which were to be considered in planning.



(Source: Barrio Planners, Inc., Reference 32)



(Source: Barrio Planners, Inc., Reference 32)

(D) Transportation Services

Information on existing transportation services within the area needs to be assembled as part of the planning process. (For large urban areas, this information has been developed for the 3-C process.) Before a new service is proposed, planners need to assess what services already exist, who the operators are, and how well they serve the community. The potential for consolidation and coordination of services should be assessed, particularly regarding social service transportation (see System Characteristics, Section 4.2.2 for coordination considerations). In Section 2.2.12, as part of the discussion of alternatives analysis, comparative work between a proposed system and any existing or proposed alternatives are presented.

An overview of the existing system would include an assessment of how people currently travel each day (i.e., walk, bike, auto, carpool, vanpool, exclusive or shared-ride taxi, subscription service, fixed-route bus service, or rail service). Some of these systems include such facilities as terminals, stops, parking structures, airports, and seaports, which should also be noted. Social service transportation should also be a part of this assessment. MPO's and Councils on Aging have done some work in compiling this type of information.

The California State Department of Transportation (CALTRANS) suggests in a study of small community needs (Reference 35) that information needed about existing systems includes the items found in the accompanying information checklist.

Data should also be assembled and reviewed by the planning team to identify potential problems or gaps in the assembled data that may impede the planning and design processes.

2.2.4 Identify Institutional Issues

Institutional issues are as varied as the communities which they impact, but they can be grouped for discussion around three central considerations:

(A) Regulatory and legal issues;

(B) Labor; and

(C) Insurance.

Additional institutional issues associated with funding requirements and with organizational arrangements are discussed in Section 2.2.5 and in Design, 3.2.1. Coordination of target market transportation services is given separate attention in Part 3 (System Characteristics), Section 4.2.2.

(A) Regulatory and Legal Issues

Many of the regulatory problems and legal questions associated with paratransit are as yet unresolved, but changes are occurring at the local community level to make it possible for these new systems to operate. More work needs to be done to bring these changes to light and to inform other communities of the ways in which obstacles to implementation were overcome or of the areas where compromise was achieved.

(i) Regulation. The large number of regulatory bodies and areas of regulation shown in the accompanying exhibit illustrate the potential complexity of paratransit regulation. Many regulatory structures are outdated and uninformed; some lack a vocabulary that includes the paratransit concept; others exclude the systems by ruling them

4.2.2 Coordination Consideration

2.2.12 Alternatives Analysis

2.2.5 Funding Sources

3.2.1 Selecting Technical Support

4.2.2 Target Market Coordination Issues

TRANSIT INFORMATION NEEDS

- Areas served
- Rolling stock type and quantity
- Route descriptions
- Annual revenue-miles and operating hours
- Frequency of service during peak periods and off-peak periods and weekends
- Annual and daily patronage (peak and off-peak periods)
- Fare structure (base, youth, senior citizen, monthly passes, etc.)
- Operating expenses
- Funding sources
- Annual fare revenues
- Maximum load factor
- Average scheduled speed

(Source: CALTRANS, Reference 35)

PROFILE OF REGULATORY FRAMEWORK

	Areas Subject to Regulation								
Regulatory Body	Rates and Fares	Insur-ance	Equip-ment	Drivers	Route	Licens-ing and Taxes	Fees	Account-ing	Entry Control
Federal									
Interstate Commerce Commission	x	x			x			x	x
Federal safety standards			x						
Airport commission	x	x	x	x	x		x	x	x
State									
Public utility commission or state corporation commission	x	x	x		x	x	x	x	x
Department of motor vehicles		x	x	x					
Airport commission	x	x	x	x	x		x	x	x
Secretary of state	x	x	x	x	x	x	x	x	x
Department of transportation	x	x	x	x	x	x	x	x	x
County									
Department of motor vehicles		x	x	x		x			
Public utility commission	x	x	x	x	x	x	x	x	
Airport commission	x	x	x	x	x		x	x	x
Department of transportation	x	x	x	x	x	x	x	x	x
City									
Department of motor vehicles		x	x	x		x	x		
Police department			x	x		x			
Taxi commission		x	x	x		x	x		x
Airport commission		x	x		x		x		
Department of transportation	x	x	x	x	x	x	x		
Joint metropolitan commission									
Port authority	x	x	x		x		x	x	x
Area transit commission	x	x	x		x		x		x
Airport commission	x	x	x		x		x		

Note. x indicates the area that is subject to regulation by the regulatory body.

(Source: TRB Special Report No. 164, Reference 119) illegal (such as shared-ride taxi services). This complexity creates a confusing and difficult situation. As Daniel Roos of MIT has pointed out, "the complex.... regulatory structure operates to prevent the effective coordination and integration of different paratransit and conventional transit services." (Reference 114)

Regulation is subject to different rules in different states and communities. Attempts have been made to clarify and assimilate regulation. The International Taxi Association collected and analyzed the statutes of every state and the ordinances of 600 municipalities as background for developing a model ordinance for regulation of public paratransit (Reference 95). In California, a model ordinance was developed by the State Assembly Office of Research (Reference 110) to:

- Provide model language for local ordinances to authorize the implementation of paratransit services;
- Provide local jurisdictions with a flexible document that can be used or tailored to local needs;
- Update or streamline existing ordinances to reflect the changing transportation needs of the public.

Generally, the basis of regulation is to provide:

- A minimum level of service;
- Minimum standards for drivers;
- A minimum level of insurance;
- Some control over rate changes; and
- Minimum equipment standards.

The way in which regulations are applied has a particular effect on the provision of shared-ride taxi service. Local regulations usually determine:

- Rate structure and level of fares which can be of three types: meter (most common), zone or a flat fare.
- Amount and type of insurance coverage (financial responsibility).
- Driver qualifications and license fees.
- Equipment safety requirements and licenses.
- Routes, schedules and boundaries.
- Method of operation (hailing and cruising restrictions).
- License to operate, controlled by limiting the number of taxicab companies, taxicabs or permits, or by allowing exclusive franchises within specific areas.
- Legality of shared-ride taxi operations.

The role of regulator for intra-city operations typically falls to a local public service commission. They, in turn, generally assign the enforcement of these local rules to the police department. The amount of regulation and the agency responsible for enacting local rules depends on several factors:

Ridership

- o If the system serves a limited group (e.g., elderly and handicapped) or a membership group and not the general public, it is less subject to regulation.

Service Characteristics

- o Systems operating with fixed routes and schedules are more likely to be regulated than demand-responsive systems.
- o If the service area is within a city, local regulation generally prevails; outside the city but within the state, the state public utilities commission may regulate some areas of operation; and, if the system is inter-state, the Federal Interstate Commerce Commission has some applicable rules.

Ownership

- o If the system is within a public agency, it is less subject to regulation; privately-operated systems are subject to more regulation; and regulations for cooperatives vary from state to state.

Fares

- o Systems which operate with no fare or donations only are less subject to regulation than those systems charging fares.

(Source: Adopted from TSC, Reference 10)

Operating certificates or permits may be required by the state. For example, in Minnesota, an operator must have a certificate of public necessity and convenience if the service is to be:

- o Offered to the public,
- o For hire,
- o For the purpose of transporting passengers,
- o By motor vehicle,
- o Over the highways, and
- o Between fixed termini over a regular route.

If only certain categories fit, the state commission may find the operator exempt from regulation: a limited group operation for the elderly may be considered a private, not public, operation.

In Minnesota, conventional bus operations were considered to meet the requirement of traveling "between fixed termini over regular routes," but taxi operations were not and therefore were exempted from state regulation. While taxis are exempt from state regulation, they remain subject to local regulation. In Pennsylvania and Maryland, regulatory powers are kept at the state level. Minnesota law also does not include the ICC category of "irregular route common carrier" to cover demand-responsive systems.

A Minnesota operator has several choices in determining what regulations will apply to the proposed system. He may:

- Appeal in writing to the state public utilities commission stating why the exemption should be considered.

- If not exempt, apply for "regular route common carrier authority," which generally has a fee and a hearing attached. If the operation will duplicate other services in the area, the operator in the proposed service area is entitled to oppose certification.

- Apply in writing for authority to become a transit commission. Insurance, annual reports, vehicle safety inspection, and driver certification are general requirements. (Reference 23)

While state requirements may differ, the applicable regulations governing system operation need to be clarified early in the planning process. In most states, the general procedure requires that a new system applying for an operating license must prove that a need for the additional service exists in the area. Hearings are held during the processing of the application, and operators in the service area may oppose certification at this time.

<u>(ii) Legal Issues</u>. Most of the legal activity surrounding existing paratransit systems has involved the arbitration of conflicts between new systems and private operators (particularly taxicab operators). Four of the 39 systems reporting on legal and regulatory issues were involved at some point in lawsuits. All four of these suits were brought by private operators. Six main issues are at the heart of these allegations:

- Compliance with UMTA grant requirements;

- Licensing provisions granted by a municipality;

- Deprivation of property without adequate compensation;

- Equal protection under the law;

- Unfair competition; and

- The buy-out provision of transit-enabling statutes.

The legal history of these issues is summarized in the Introduction, Section 6.6.

<u>(iii) Guidance</u>.

- Identify the local regulators and obtain copies of regulations affecting the proposed system.

- Prepare a description of the proposed system including service area, fares, eligible ridership, and operator options (described in Section 3.2.1) and ask the regulatory body to define areas of regulation, certification, etc.

- Check whether system requires operative authority from the state regulatory commission (certificate of public convenience and necessity).

- Check for constraints in the following areas generally subject to regulation:

Go to 6.6 Intro. Summary of Legal Issues

D 3.2.1 Operator Options

2.2.4

- Rates and fares;
- Equipment (particularly safety requirements);
- Driver's licenses and qualifications;
- Routes;
- Licenses and taxes;
- Fees;
- Accounting;
- Entry control; and
- Shared-ride taxi legality.

o If complex issues are involved, decide if legal assistance will be required.

There are divergent views on regulation. They range from "If it's not in the ordinance, you can't do it" to "don't treat all the existing rules as gospel edicts, but press for change." Many potential constraints can be changed at the local level by checking with local authorities about the feasibility of relaxing constraints or negotiating some of the problems that confront the system.

In the case of shared-ride taxi service, some educational process or presentation to policymakers and the public may be needed to point out the potential of the relatively unfamiliar service and to indicate that precedents for such a service do exist.

Check for possible franchise conflicts, and be prepared for allegations of duplication of services. Be prepared to show that the need for the proposed system actually exists. Otherwise, severe legal delays and lawsuits can develop (see System Documentation on Tucson, Arizona; Ann Arbor, Michigan; and Orange, California).

Go to
Appendix A-4
System Summary Sheets
Tucson,AZ (#82), Ann Arbor, MICH. (#80)
Orange, CA., (#63)

Potential regulatory pitfalls include:

- Lack of uniform definitions for modes of ground transportation.
- Lack of a uniform transit vocabulary.
- Lack of definite jurisdictional boundaries.
- Lack of a uniform code for regulatory control.
- Lack of common purpose among legislators and regulators.
- Lack of proper definition of the public interest.

(Source: TRB Special Report No. 164 on Paratransit, Reference 119)

(B) Labor

"The uncertainties of the impact of labor requirements are a significant barrier to wider applications of paratransit. There is a strong concern that the application of transit wages and work rules to paratransit could drive taxi operators out of business as surely as a public agency running subsidized paratransit in competition. Yet there is limited practical experience in working out paratransit labor issues and the rate at which paratransit is introduced must be timed to allow labor issues to be raised, worked out and tested in an orderly manner. Too hasty imposition of paratransit could lead to the formalization of existing labor practices before better ones can be developed and proven. (Reference 31)

The following labor issue discussion focuses on labor organization, union contractual arrangements, the 13(c) employee protection provision, and guidance for pilot systems.

(i) Labor Organization. Drivers comprise the major labor group within transit systems, and should therefore be a major consideration when planning a new paratransit system. Some characteristics of this labor pool are outlined below:

Union Bus Drivers

- Represented by Amalgamated Transit Union (ATU), Transit Workers Union (TWU), or United Transit Union (UTU).
- Operate under specific rules covering wages, fringe benefits and work rules.
- Paratransit activity associated with larger dial-a-ride systems (e.g., Rochester, New York; Santa Clara County, California; and Ann Arbor, Michigan).

Non-Union Bus Drivers

- Mainly associated with small community systems (e.g., Michigan DART program).

Union Taxi Drivers

- Where unionized, generally with the Teamsters.
- Operating rules less strict than bus operations.
- Perform shared-ride operations and elderly and handicapped special transportation services, often associated with social service organizations.

Non-Union Taxi Drivers

- Operate services similar to union taxi operations.

Volunteer, Part-Time, CETA

- Associated with small community systems or social service agency transportation.

Responses from existing systems showed the following breakdowns in their labor organization:

	No. of DAB Systems	No. of SRT Systems	Total Systems Number	Total Systems Percent
Non-Union	20	10	30	48
Union	7	4	11	18
Part-time	10	--	10	16
Other (CETA or city employees)	7	--	7	11
Independent union	2	1	3	5
Volunteer	1	--	1	2
Total	47	14	62*	100

*Includes multiple responses.

There are a variety of organizational arrangements for the taxi labor force. (Transit union organization will be discussed under (ii) union labor contracts.) Four different types of operations are:

- Independent Driver: an owner-driver
  - Considered an independent contractor
  - No employer-employee relationship
  - No obligation to provide service on a regular basis
  - Found in free-entry cities (e.g., Atlanta, Georgia and Washington, D.C.)
  - Not subject to withholding tax or benefits
- Lessor and lessee-driver
  - Pays fee for use of vehicle
  - Considered independent contractor by IRS
  - May contract for dispatching, fuel, maintenance, etc.
  - Increasing number of firms operating this way (7.7% in 1973 to 12% in 1975)
- Cooperatives: independent owner-driver
  - Share dispatch, maintenance, bulk fuel purchase, tires, group liability insurance
- Employer and driver-employee
  - Most common organization (71% of taxi operations in 1975)
  - Driver works for firm and is paid a commission (43%-50% of fares)
  - Employer pays minimum wage, social security taxes, payroll tax and benefits. Provides insurance, maintenance, dispatching, gas and oil; meets requirements for operating permits or franchises from local government. (References 94 and 98).

The labor share of system operating costs is discussed in Section 2.2.11. According to one study (Reference 104), the "current rule of thumb in paratransit implementation is that urban systems are bound to union labor while rural and small community systems pay roughly two-thirds of prevailing union rates to non-union personnel." This study points out three main reasons that smaller systems are non-unionized:

- Higher costs would kill the project;
- They are too small to attract union organizations; and
- They are located in communities where conventional transit modes have not been successful.

In the past, contract negotiations with unions have sometimes presented problems, but they have rarely been insurmountable. One successful agreement in Rochester, New York is considered by organized labor to be a model contract for a dial-a-ride system. (This agreement is reproduced in SCRAPS Section 6.3.) In Cleveland, Ohio, results of a transit authority-union negotiation was an agreement that effectively allowed:

- Allocation of project funds (two-thirds to the union bus operation in high-density areas and one-third to a private taxicab operation in low-density areas); and

2.2.11
Operating
Costs

6.3
Rochester, New York
Work Rules Agreement

- Creation of a new job definition for the driver of a vehicle seating fewer than thirty people, and correspondingly lowering the wage rate for that job.

The full text of the Cleveland agreement is reproduced in SCRAPS Section 6.5.

(ii) Union Labor Contracts. Transit union contracts cover two major areas: (1) wages and fringe benefits; and (2) work rules, scheduling, job classifications, etc. Wage factors are discussed in Section 2.2.11 under cost estimates. One study (Reference 104) summarized the major problem areas between unions and management as wage scales, full-time work guarantees (therefore excluding part-time labor) and restrictive job definitions.

Work rules are categorized as follows:

- Scheduling, or matching employees to transit runs. This process includes considerations of layover time, make-up time, and spread pay. Considerable variety exists in different communities in different sections of the country, but the following rules from Reference 104 are typical:
  - Drivers are guaranteed 40 hours pay per week, even though they may not work the full amount.
  - Straight runs (eight hours' work in nine hours) must equal at least 60% of total runs.
  - Any driver whose shift spans over 10.5 hours receives a percent spread premium for any additional time; any spread time in excess of 12 hours is awarded a double-time premium.
  - Regardless of the work performed, a two-hour minimum must be paid.
- Seasonal changes in schedules. (Drivers choose their work runs at intervals throughout the year, typically every three to six months.)
- Labor utilization. (Job definitions are particularly important, since most rules do not allow part-time drivers.)

A labor-management study reviewed the provisions of labor agreements and developed a list of common concerns in labor agreements. These are shown in the following exhibit. Most of the issues of concern were economic, "probably due to the fact that collective bargaining in the mass transit industry has a long history, and many, if not most, non-economic issues have already been settled." (Reference 109)

(iii) Section 13(c): The Employee Protection Provision. In the past, when most transit operations were privately owned, collective bargaining and employee protection were issues governed by the National Labor Relations Act (NLRA). With the shift to public ownership, transit was no longer under that authority. Public employers abided by state and local labor regulations which the unions considered to be inferior. The unions therefore worked for legislation to cover collective bargaining and employee protection to secure the rights they enjoyed under private ownership. In 1964, Section 13(c) of the UMTA Act was enacted to provide a continuation of these rights. Any transportation operation that became publicly-owned and received federal grant monies must comply with federal requirements. "It shall be a condition of any assistance...that fair and equivalent arrangements are made...to protect the interest of employees

6.5
ATU Work
Agreement

2.2.11
Wage Factors in
Operating Costs

SUMMARY OF ISSUES COVERED IN LABOR AGREEMENTS

Union Security Issues / Job Assignment	Wages / Vacation, Sick Leave, Funeral Leave / Contingent Benefits	Negotiated Impasse Resolution Procedure / Public Interest / Management Rights

Union Security Issues
 	
Bargaining unit designation
Designation of union as exclusive representative
Union security clause
Provision for dues checkoff and administration and cost of checkoff
Paid time off for officers and members for union business
Superseniority
Provision for union meetings on property
Provision prohibiting contracting out
Provision prohibiting supervisor from performing bargaining unit work
 	
Job Assignment
 	
Minimum hour guarantees
Work week and scheduled days off
Work scheduling
  Basis for selection of work
  Requirements for advance posting of work
  Required number of bids per year
  Changes, additions, and deletions of regular runs
  Procedures for allocation of overtime
Extra Board
  Scope
  Provisions for rotation
  Payment for administrative error
Promotion procedure for garage employees
Layoff procedure
Provisions for premium pay
  Rate of pay for time worked on a holiday
  Rate of pay for time worked on scheduled day off
  Rate of pay for time worked in excess of regularly-scheduled work day or in excess of 8 hours
  Spread time
  Shift premiums
  Training allowances
  Longevity pay
	Wages
	
	Wage rate ranges and steps
	  Drivers
	  Maintenance employees
	Negotiated wage rates
	  Drivers
	  Maintenance employees
	Cost of living allowance
	Other forms of payment
	  Preparatory time
	  Court appearances
	  Report pay for extra board
	  Time spent completing accident reports
	  Intervals between pieces of runs
	  Attendance of safety meetings
	  Check-in time
	  Call-in time
	  Meal relief
	  Relief time
	
	Vacation, Sick Leave, Funeral Leave
	
	Vacation
	  Amounts for years of employment
	  Eligibility
	  Scheduling
	  Amount of vacation
	  Use of paid vacation
	Sick leave
	  Rate of cumulation
	  Eligibility requirements
	  Use of paid sick leave
	Funeral leave - amount and eligibility of specific relatives
	Holidays
	
	Contingent Benefits
	
	Insurance programs
	  Hospital - Medical-Surgical
	  Major medical
	  Life insurance
	  Accident insurance
	Pension, Retirement Plan
		Negotiated Impasse Resolution Procedure
		
		Steps in negotiated grievance procedure
		Definition of a grievance
		Time limits for appeals and decisions
		Special grievance procedure
		Union rights in the negotiated grievance procedure
		Civil Service appeals procedure
		Arbitration
		  Authority of arbitrator's award
		  Scope of arbitration
		  Time limits
		  One level vs. two levels of arbitration
		  Selection of arbitrator(s)
		  Provision for expense of arbitration
		
		Public Interest
		
		Service
		Safety
		Passenger treatment
		First aid training
		Promptness
		Customer satisfaction
		Safety meetings
		
		Management Rights
		
		Management rights clause
		Management rights with respect to specific issues
		  Selection of employees
		  Layoffs of employees
		  Determination of length of runs
		  Schedule changes
		  Technological changes
		  Time standards for runs
		  Apprenticeships
		  Bidding of runs

(Source: Jennings and Smith, Reference 109) affected by such assistance..." Such protective arrangements include guarantee of collective bargaining rights, priority of rehiring, and protection against a worsening of their position. Section 3(e) of the Act also states that no financial assistance will be provided to public bodies acquiring a private mass transportation operation or competing with or acting as a supplement to an existing mass transportation company unless the Secretary of Labor certifies that such assistance complies with the 13(c) provision.

A key point of the Act is the guaranteed protection to all "employees affected," not simply affected transit employees. As a matter of practice, the Departments of Transportation and Labor have been interpreting this section as applying only to transit employees." (Reference 109). Another key point is that 13(c) protects the individual employees, not the jobs.

The 13(c) provision is a concern of management, unions and operators of federally-funded systems. (One exception is that programs receiving 16(b)(2) funds are exempt; see Section 2.2.5 for guidance.) The 13(c) provision is better understood when applied to conventional transit operations rather than paratransit. Some believe it was never intended to cover paratransit, that paratransit has grown up largely outside of the union environment and without federal assistance, and that paratransit has enough substantial differences in operation to merit new rules.

Alan Altschuler notes,

> Paratransit is posing the most unsettled issues in the arena of section 13(c) labor protection. Existing transit employers have shown virtually no interest in providing dial-a-ride or special services.

URBAN MASS TRANSPORTATION ACT OF 1964

Section 13(c)*

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 (2)(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.

*49 U.S.C. 1609 (c)

NOTE: Section 5 also must comply with 13(c) requirements. Later Congressional Record inserts indicate that 13(c) was applicable to Section 6 demonstration programs as well.

2.2.5 16(b)(2) Funding

> Demand-responsive transit has been developing, therefore, primarily outside the scope of existing transit, using unpaid labor or labor paid at substantially below the prevailing transit rates. Union leaders worry that such competition may undermine existing labor standards, may drain patronage from existing transit operations, and may draw public subsidy dollars away from conventional transit...By contrast, the primary concern of federal officials is what the effect of paratransit development may be on the scope of section 13c coverage--in particular, on the issue of taxi employee coverage. To the extent that UMTA funds are used in support of taxi-like operations, or of operations that are clearly competitive with taxi service, the case for exclusion of taxi employees from section 13c protection is weakened. The issue goes well beyond the question of how to draw the boundary between transit and taxi service because the decisive test under section 13c is simply adverse impact, not definition as transit. (Reference 101)

The exclusion of taxi employees from Section 13(c) protection turns on a semantic issue. In the past, the term "mass transportation"..."generally was synonomous with conventional mass transit." (Reference 121) By adhering to this narrow interpretation, UMTA was generally able to distribute funds within the prevailing system of conventional bus and transit lines. "The only competition for funds was among urban areas...Today, however, the competition between conventional transit and other potential 'mass transportation' services is making it increasingly difficult for UMTA to determine what service modes within an area's comprehensive system should get UMTA's money." (Reference 121)

An unsettled question remains: Are shared-ride taxi operations mass transportation, and therefore eligible to receive funds directly and to receive 13(c) protection for their employees? The prevailing view is that if shared-ride operations are an incidental part of the total taxi operation, employees are not covered under the 13(c) provision. This view is stated in the proposed federal policy (Reference 8): "where an organization is providing paratransit service as an incidental adjunct to its main business, UMTA will not consider such an organization to be mass transportation company" under Section 13(c). What constitutes an "incidental adjunct" is not spelled out but, recently, decisions have been made in several cities:

- Akron, Ohio. A taxi company was ruled as exempt because less than 5% of the taxi company's business was generated by paratransit services.
- Pittsburgh, Pennsylvania. The Department of Labor ruled that 15% of Colonial Taxi's business was similar to mass transportation services offered under a federally-funded brokerage project, and taxi company employees were to be covered by the local 13(c) agreement.
- New Haven, Connecticut. The Department of Labor ruled that if 50% of a taxi employee's time is spent providing shared-ride service, similar to that to be federally-funded in an operating assistance grant, 13(c) protection extends to these employees.

Problems associated with coverage of taxi drivers include:

- The unique employment arrangement of lessee-drivers;
- The indeterminate wages of most drivers; and
- The part-time status of most taxi operators. (Reference 109)

According to a study of labor-management relations (Reference 109), the major criticisms of the 13(c) provisions are:

(a) it impedes system efficiency;

(b) it can add potentially undefined costs to the provision of transit service;

(c) it can "lock" communities into greater levels of service than the market level can reasonably support;

(d) it can be used to enhance unions' bargaining power or as an instrument of "blackmail"; and

(e) it may discourage public authorities from seeking federal assistance.

"...research revealed that the last criticism is the only operational problem of Section 13(c). While management and union officials are very much attuned to 13(c), it does appear that some public officials are reluctant to endorse grant applications because of fears associated with the negotiations for Section 13(c) agreements. A possible way to mitigate this problem is to educate the local public officials as to the purpose and actual results to date of implementing Section 13(c) agreements. While this appears currently to be the main concern with Section 13(c), there are other potential substantive problems which must be addressed, such as paratransit operation including the definition of 'affected employees.'"

(iv) Guidance. The Transportation Development Agency of Canada (Reference 4) suggests the following policy for establishing good community labor relations:

"An effective labour relations policy should be designed to promote the maximum utilization of employees under reasonable working conditions. Both labour and management must recognize that each has equal rights and responsibilities to fulfill in regard to each other, the transit company, and the riding public. Both groups are obliged to meet at reasonable times to bargain in good faith with respect to wages, hours, and working conditions. A good labour relations policy begins with tolerance, co-operation, respect and trust and is attained by policies of recruitment, training and discipline that reflect these attitudes."

When applying for federal financial aid, remember that compliance with Section 13(c) will be required. The official process for 13(c) certification is:

- o Application is submitted for federal funding to DOT. It should include assurances of compliance with the 13(c) provision.
- o DOT notifies the Department of Labor (DOL), which is responsible for 13(c) certification.
- o DOL notifies the unions involved.
- o If a local agreement is reached, DOT certifies the project; if no local agreement is reached, DOL offers assistance in the negotiations.

Bring labor representatives into the project planning discussions early. Reasonable and innovative arrangements have been worked out in the past. Local negotiation is the crux of 13(c) agreements. DOL guidelines were recently issued to clarify the process of certifying agreements and, recognizing the time factor involved with funding applications, a timing schedule has been added. (See SCRAPS Section 6.1 for DOL guidelines.) The American Public Transit Association (APTA), working with unions and government, designed a model 13(c) agreement for guidance. This agreement is included in SCRAPS Section 6.2 .

6.1
Dept. of Labor
Guidelines

6.2
APTA 13(c)
Agreement

(C) Insurance

The insurance issue is the main concern of taxi operations, particularly today with the escalating costs of public liability and workers compensation insurance. In the past, insurance for small bus systems was expensive and hard to obtain. City- or county-operated bus systems have recently been able to arrange coverage under "umbrella policies" that provide vehicle insurance for several government agencies (e.g., public works). In Fairfield, California, the city paid $733 per month for liability insurance, or 5% of the operating cost of the system. This did not include worker's compensation, group insurance, theft bond, or general business insurance, which were covered by the system management contractor. Transit authorities or districts that operate fixed-route buses are allowed to add dial-a-ride buses to their fleet policy.

In California,

"legislative concern with insurance has extended to an amendment in 1975 to the California Insurance Code (Section 11580.1), stipulating that no insurance policy can exclude from coverage the use of a motor vehicle in the performance of volunteer service for a nonprofit organization or governmental agency by providing transportation to senior citizens or physically or mentally handicapped persons. The section does not apply if the volunteer receives a remuneration in excess of $.15 per mile for vehicle costs. Although this section is not applicable to general public transportation, its passage evidences legislative awareness of the insurance problem." (Reference 41)

For taxi companies, insurance rates have been rising rapidly. Eleven of the 39 systems supplying information (primarily taxi companies) stated that they experienced severe problems either in obtaining insurance or in meeting the high costs incurred.

(i) Obtaining Insurance. Problems with obtaining insurance have been blamed on several factors:

- Constraints on insurance companies. Many states require insurance companies to maintain reserves on a three or four to one ratio to the business they underwrite. In this way, companies are prevented from overextending their reserves. Because they can be selective about business, insurance companies are more likely to reject uncertain or slightly complex applications (e.g., the shared-ride taxi company).

- Lack of experience or data. Shared-ride taxi service, it is argued, lacks a good data base upon which to compile statistics needed to support lower insurance rates. It has been speculated that such a data base is two to three years away. One insurance seeker reacting to this statement noted the "vicious circle" aspects of the situation, since there will be no data if nobody can get into the business for the want of insurance.

(ii) Cost. The increased cost of insurance is blamed on higher costs of vehicles and maintenance, medical treatment, out-of-court settlements and large jury awards. In 1970, insurance represented 5.7% of taxi operating costs; by 1975, it represented 9% of those costs (Reference 94). A Commission on Aging hearing found a range of rates from

$250 to $4,000 per car per year, reflecting the tremendous difference in rates and requirements among states.

(iii) System Experience. System experience documents several responses to insurance problems in individual states, as listed in the facing exhibit.

Recognition of the taxi insurance problems led a Southern California regional body's (SCAG) Paratransit Task Force to recommend that the following action be taken:

- Worker's Compensation Appeals Board and State Office of Employment Opportunities should redefine a taxicab lessee as an independent contractor (to comply with IRS definitions). (In California, a leasing operation must carry worker's compensation and unemployment insurance for drivers whom they consider to be employees.)
- Support of legislative action which reduces the cost of insurance for all transportation providers.
- Changes in local taxi ordinances for acceptance of any insurance carrier admitted by the State Insurance Commissioner.
- Collection of data on the history of dial-a-ride systems to support efforts to change the California Insurance Rating Board's recommended paratransit insurance rates.

SYSTEM EXPERIENCE WITH INSURANCE

- In the Los Angeles area, it was found that some small operators opted to carry property damage coverage only, without public liability. If sued, the operator went out of business. A number of operators took a costly and risky course and obtained policies for large deductibles and self-insured for all but major claims (Reference 116). Taxicab insurance reportedly can be as high as $5,000 per year.
- Minnesota has no-fault insurance which added $260 per year to each taxi vehicle because of the personal protection provision of no-fault. Each cab is required to carry coverage of $30,000 public liability, $20,000 medical, and $10,000 non-medical, and each company must also carry worker's compensation. One operator commenting on no-fault insurance reported that his rates increased to about $1,500 per car per year just for liability. (Reference 23)
- In Pennsylvania, the two largest taxi companies are self-insured and have their own claims adjuster for rapid claims settlement. This is probably not an option for smaller operations, which include most taxi companies (in 1975, 62% of all taxi operations had less than 25 cabs).

2.2.4

(iv) Guidance.

- Check availability of insurance for the proposed system.
- Check cost, conditions and coverage.
- Check for any federal, state, or local requirements affecting insurance with the local public utilities or public service commissions which may control insurance coverage. (In Maryland and Pennsylvania, taxi options are regulated at the state level; in California, the State Public Utilities Commission controls service only when taxis operate beyond city boundaries.)
- Follow developments in the legislature for proposed laws to lower rates.
- Keep operating records current, including any accident reports which may be offered in support of a bid for lower insurance rates.

Insurance is costly, and may be difficult to obtain. Determine requirements, availability and costs early in the planning process.

2.2.5 Identify Funding Sources

Since profitable demand-responsive paratransit services are relatively few and far between (e.g., SRT services in Little Rock, Arkansas, Hicksville, New York and Madison, Wisconsin), planners should not expect farebox revenues to cover the total cost of these services. Demand-responsive transit systems generally receive a substantial portion of capital and operating funds from public subsidies. However, despite this source of support, 24% of the paratransit operators surveyed said they experienced severe funding problems, and an additional 32% cited funding as a constraint.

Part of the problem lies in the large number of programs created by the federal government to distribute funding. Over 114 programs allocated over two billion dollars in fiscal year 1976 to "provide transportation of people in support of program goals" (Reference 106). But despite the large sums of funding available for transit, the primary recipients are social service agencies which either operate their own paratransit services or independently contract for services, leaving a small percent of the funds for communitywide services. Of that money, much has been earmarked for conventional bus and rail services.

To compound these funding problems, existing programs may suddenly find their sources of funding cut off or significantly modified as government policies change. To avoid being left financially "high and dry," and to maintain local fiscal control, many communities have relied upon local and/or state funding sources. The chart on the right identifies the funding sources for 75 systems. Although no exact funding statistics are available, on the average each system depends on more

FUNDING SOURCES

Source	General Market (46 Systems)		Target Market (29 Systems)	
	Number	Percent	Number	Percent
Federal	13	28.3	19	65.5
State	22	47.8	13	44.8
County	4	8.7	4	13.8
City	20	43.5	19	65.5
Special District	3	6.5	3	10.3
Local Organization	3	6.5	7	24.1
Other	5	10.9	--	--
Total	70	152.2	65	224.0

Source: SYSTAN

than one sponsor to cover their costs, with 47% of the systems surveyed using some or all local funds (city, county, special district, and local organization).

(A) Available Sources

A planner's first task is to review funding sources used for existing transportation services and to identify the full range of potential resources, starting at the local level. The facing checklist may be helpful in this process.

(i) Local Resources. Public funds currently in use include: revenue-sharing and general funding sources, community development block grants, property taxes, sales taxes, and other local taxation measures. Some communities have tapped Comprehensive Employment and Training Act (CETA) resources for personnel needs; CETA employees must meet income, unemployment, and other federal criteria. Other communities have arranged for private financing through industrial or commercial interests, especially when targeting commuter- or shopper-oriented paratransit services. For more specific information on funding target market services, refer to Section 4.2.3.

There are usually no planning requirements attached to local funding sources; however, some states do have statutory limitations on local funding for transportation facilities and services. Also, local funds are not restricted to public transit operations, and thus may be used to subsidize private operators (i.e., shared-ride taxis). System experience also shows that those operations using local funds have a greater degree of control and community commitment to support their services.

POTENTIAL RESOURCES FOR FUNDS

LOCAL

Revenue Sharing
Property Tax
Sales Tax
Special Transit District Tax
Community Development Block Grants
Comprehensive Employment and Training Act (CETA) Grant
Other Public Sources (e.g. income, payroll, public utilities tax
Private Sources*

STATE

Transit Capital Assistance
Transit Operating Assistance
Technical Assistance
Demonstration Program
Direct Budget Allocation
Special Bond Issues
Other (e.g. lottery)

FEDERAL

Capital Grants (Section 3)
Capital and Operating Grants (Section 5)
Demonstration Grant (Section 6)
Technical Assistance Grant (Section 9)
Private/Non-Private Grants (Section 16(b)(2)*
Other (e.g. HEW, HUD, etc)*

*For more detailed listing and information, refer to Section 4.2.3

(Source: SYSTAN)

4.2.3
Target Market
Funding Sources

As a general rule, the implementation time lengthens as one goes further from home to acquire funding, so that systems funded from local sources can be put in service more quickly than systems relying on state or federal funding.

In most cases, federal grants and state funds can be combined with local support to cover the total cost of demand-responsive transit systems. By tapping local sources initially, while awaiting receipt of long-term funding commitments, communities can take advantage of multiple funding sources without unnecessarily delaying their proposed start-up date.

(ii) State Sources. Funds can be provided solely by the state or through matching local-state-federal share programs to aid communities in obtaining federal dollars. In most cases, state aid programs have adapted their requirements from the federal level. While most states provide some support, usually relying on general revenue sources (e.g., highway funds and gasoline, sales and property taxes), each state has its own funding program(s) and restrictions. For example, Pennsylvania law prohibits the funding of demand-responsive service in urbanized areas. SCRAPS Section 7 provides a breakdown of individual state capital, operating and technical assistance programs. Of particular interest are Michigan's 100% first-year funding program and California's Local Transportation Development Fund; both these programs have been the impetus for many successful dial-a-ride and shared-ride taxi systems. Minnesota and Wisconsin have recently budgeted state aid programs, with other states expressing similar interests. SCRAPS Section 7.2 contains outlines of the California, Minnesota, and Michigan programs.

7.2
State
Funding
Programs

(iii) Federal Sources. The U.S. Department of Transportation awards a number of assistance grants, as shown in the next exhibit. The Federal Highway Administration recently modified the provisions of the Highway Trust Fund to allow the diversion of interstate highway monies to mass transit uses. At least one state, New York, has applied funds from this source to the purchase of paratransit operating equipment.

In addition to the Department of Transportation, funds may come from the Departments of Health, Education and Welfare, Housing and Urban Development, Agriculture and Labor. Most of this aid is directed to target market groups such as the elderly, and require specific authorizations and verifications. For more information on these sources, refer to Section 4.2.3.

(B) Identify Funding Limitations and Constraints

The size of the community considering paratransit service will affect the type and method of funding, which in turn will influence the shape and scope of the project. UMTA funding requirements set specific size guidelines:

- Urbanized areas greater than 200,000 population: the Metropolitan Planning Organization (MPO) receives capital and operating assistance directly from the federal government.
- Areas of 50,000-200,000 population: State disburses money received from the federal government to local governments for capital and operating expenses.

4.2.3
Target Market
Funding Sources

PRIMARY U.S. DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION FUNDING OPTIONS

SOURCES	PURPOSE	FUNDING LIMITATIONS	WHO CAN APPLY	REQUIREMENTS	APPLICATION PROCESS
Capital Assistance Grants UMTA Section 3	To purchase, construct or finance land, vehicles, facilities and equipment	80% federal, 20% local; state matching basis; most commited to conventional transit programs; UMTA encourages Section 5 for paratransit	State or local public agencies and operators	Agency authorization; assurance of non-federal share; 3-C planning process; public hearing; Section 13(C) certification; civil rights compliance; include TIP[1]	Operator submits pre-application[2] to UMTA Office of Capital Assistance for review, then formal Section 3 application[2]
Capital and Operating Assistance Formula Grants UMTA Section 5	To assist capital-related or operating expenses	Capital: 80% federal, 20% local and state; operating: 50% federal, 50% local and state on matching basis, excluding fare revenue; restricted to areas larger than 50,000 population	Public and private agencies	Same as above, plus half fares for elderly and handicapped, maintenance of effort, uniform accounting	Operator submits grant application[2] to UMTA Office of Capital Assistance
Transit Demonstration Program UMTA Section 6	To develop, test and promote new facilities, techniques, equipment, or methods for research and development	Short-term (1-3 year) capital and operating funds available; local financial support not required, but will improve project's funding potential; cannot cover existing or conventional transit operations	Public and private agencies	Innovative or experimental project, unique in location or application; project monitoring & evaluation to document results; Section 13(C) requirement	Informally determine UMTA's interest in proposed project; obtain grant application package, submit to UMTA Office of Research and Development
Planning Assistance Program UMTA Section 9	To develop coordinated local transit plans and programs	80% federal, 20% local and state; distributed by formula to states	State or local public agencies	3(C) planning	
Elderly and Handicapped Services UMTA Section 16(b)(2)[3]	To provide special transit service where existing or proposed public and private services are not adequate	Capital: 80% federal, 20% local; distributed by formula to states	Urban, rural, non-profit and private organizations	Meet special needs of elderly and handicapped	Submit application to state; state submits consolidated application to UMTA for selected applicants

[1]Determine compliance with most requirements during the TIP approval process.

[2]Grant application samples are contained in SCRAPS Section 7.3.1.

[3]For additional details on TM funding sources, see System Characteristics Section 4.2.3.

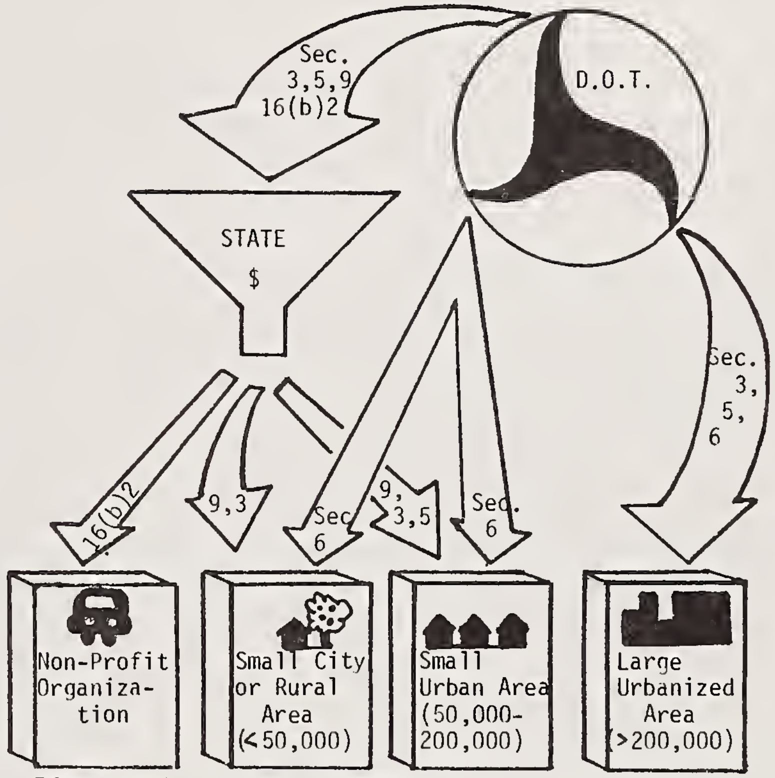
(Source: Adapted from the Michigan Dial-A-Ride Transportation Operations Manual, Reference 51, and the San Diego Region Dial-A-Ride Guidelines, Reference 60) o Areas of less than 50,000 population are only eligible for capital assistance.

To qualify for federal dollars, urbanized areas must also include provisions for a comprehensive, coordinated and continuous (3-C) planning process; documentation in Transportation Improvement Program (TIP) Annual Element, or the Transit Development Program (TDP) and regional A-95 review. Some local and regional representatives, such as the Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area require that all agencies seeking approval of funding applications belong to a "Paratransit Coordinating Commission." MTC's intent is to increase the "cooperation, coordination, availability, and effectiveness of special transportation services by minimizing overlap and duplication in the use of resources."

UMTA regulations issued in 1976 also require a minimum of 5% of the total federal transit operating assistance funds be directed to mobility-impaired individuals, such as the elderly and handicapped. Additional specific planning requirements are defined in UMTA's External Operating Manual (Reference 155).

The choice of funding will also affect the time allotted for system development. If federal capital grants are sought, the time between the initial application and the start of service can be expected to be at least ten months. In the absence of federal funding delays, the time between conception and start-up is likely to be determined by the vehicle and equipment procurement process. In practice, this time span may be reduced to approximately four months (Reference 36). If existing equipment is available, the demand-responsive service may come to life even sooner. Since communities will need to

FUNDING CHANNELS



UMTA Section	Title	Dollars in Millions*
Section 3	Capital Grants	$ 1,395
Section 5	Capital and Operating Assistance	432
Section 6	Research and Demonstrations	63
Section 9	Technical Studies	48
Section 16(b)(2)	Private Non-Profit Organization Grants	22**
FHWA Section		
Section 147	Rural Demonstration	15

* Fiscal Year 1976, including transition quarter through September 30, 1976.
** Allocated

(Source: SYSTAN)

2.2.5

reapply for operating funds each year, keep records of the elapsed amount of time and contact helpful individuals during this initial application for future referral.

To protect competitive interests, UMTA regulations require private transit and paratransit operators be given a fair and timely opportunity to participate "to maximum extent feasible" in developing the local transportation program and in providing services (UMTA Section 3e).

Although private operators may not be directly eligible for federal grants, the public operator, city, county or state can apply for UMTA funds, and lease the vehicles to a private bus, shared-ride taxi, or social service organization for the actual operation. UMTA Sections 3, 5 and 6 funds will not be appropriated unless transit labor interests are protected, requiring a Section 13(c) Department of Labor approval and sign-off. If your community's proposed demand-responsive transit service gets bogged down by union controversies, and local funding arrangements are not possible, consider some of the other federal financial assistance programs, such as UMTA's Section 16(b)(2) and FHWA's Section 147; both these programs are exempt from the 13(c) mandate.

(C) Guidance

Identify local, state and federal authorities, agencies or districts that distribute or act as intermediaries in funneling or transferring funds. Refer to SCRAPS Section 7 for a directory of UMTA offices; consult appropriate state and federal directories for non-UMTA sponsored programs.

Contact appropriate agencies to determine the availability of and competition for funds, additional constraints and limitations, estimated chance of success, expected time between receipt of application and award, and application and instructions for completing forms.

Determine what impact possible changes in funding levels or sources would have on the proposed service. Are alternative resources available? This is particularly important if considering a demonstration project that provides only short-term funding.

If applying for federal Technical Planning Assistance (Section 9) or for particular state or local funds, complete and submit application at this time. Preapplication for federal assistance can be submitted for UMTA's review after the project receives the "go-ahead," and budget estimates have been determined.

7.3.2
Federal Offices

2.2.6 Identify Candidate Sites

Site identification is the first of the specific planning steps to deal with the concept of transportation improvements. Its purpose is to select and describe areas that are logical candidates for new or modified demand-responsive transit services. The general locations of interest will have been suggested by the examination of existing conditions (see Section 2.2.3), but this earlier work is more in the nature of cataloging symptoms than of beginning to formulate a cure. Site identification can be divided into four steps:

1. Identify transportation requirements;

2. Examine potential census tract characteristics;

3. Explore boundaries; and

4. Rank alternative sites.

Each of these steps is developed in some detail in the remainder of this subsection.

(A) Identify Transportation Requirements

At the outset, requirements for new transportation services are not generally clear. Symptoms of need or deficiency, such as declining fixed-route bus patronage and service, increased automobile congestion and a plethora of formal or ad hoc target market services, point to a general inadequacy of existing public transportation services. However, these symptoms almost never suggest a valid solution. By identifying the nature and location of the principal needs, they become the focus for service improvements.

2.2.3
Inventory of
Existing Conditions

There are a variety of ways that transportation requirements can be investigated. All involve the imaginative use of available data--principally census data. One approach uses census tracts as the initial geographical unit for examination (see exhibit on page 2-45). These tracts represent the smallest geographical breakdown for which the desired data are conveniently available.

AVOID DETAIL FOR DETAIL'S SAKE. Block-face census data (which provide census information by block for each side of the street) are available for some urban areas. However, these data are so voluminous as to make the analysis slow and costly, and thus defeat the purpose of preliminary planning.

Many cities have transportation zones that were used in past comprehensive planning studies. Travel data and sometimes demographic data are available for these zones. Even if the demographic data are adequate, the number of zones is too large for the level of analysis needed.

The procedure for identifying transportation requirements can be performed in a relatively short time using nothing but census data. It will not identify all of the areas of a city that can benefit from demand-responsive transit, but it will identify the parts of a city that are the most likely initial candidates for new services.

(B) Examine Potential Census Tract Characteristics.

Once the census tracts with the highest potential for new demand-responsive transportation have been identified, try to learn more about those tracts. (It is still convenient to keep data on file by census tract

STEPS IN ONE APPROACH TO REQUIREMENTS ANALYSIS

1. Identify all of the census tracts of potential interest in the urban area. (Omit CBD, airport, and other major activity center tracts.)

2. For each census tract, list:

   a. Population
   b. Work trips (number by automobile driver, automobile rider, public transit, taxi, walking, etc.)
   c. Number of households
   d. Employed persons
   e. Income distribution of households
   f. Distribution of automobiles among households (e.g., number of households with 0, 1 and 2 or more automobiles)

3. Examine the work trip data. Work trips by automobile drivers gives the number of the tract's automobiles that are used for work trips.

4. Calculate an automobile balance for each tract:

   Automobiles available for non-work trips =
   Total automobiles - Automobile drivers

5. Calculate the size of the non-employed population for each tract (total population - employed population). Also calculate the fraction of the population that is not employed.

6. Calculate the number of non-employed individuals per available automobile (non-employed individuals = non-employed population/available automobiles). This is a measure of relative mobility for non-work trips. Census tracts with large numbers of individuals per available automobile may have:

   a. Low income (few automobiles), or
   b. Large populations of non-drivers (young and elderly).

   In either case, a tract is a candidate for transportation service improvements.

7. Using two criteria (unemployed persons per automobile and the fraction of of unemployed persons), either rank the census tracts in order of increased mobility or establish a cut-off value reflecting some minimum mobility level. This step will identify the census tracts that need first consideration for transportation improvements.

(Source: SRI, Reference 47)

to provide maximum flexibility for the later selection of service area boundaries.)

Other data sources will provide the information needed to combine census tracts into service areas and, later, to estimate demand and match transportation services to areas. Target items of information are listed in the facing exhibit. These data are not always available from the Census Bureau; many of the data needs can be found at the local planning office, or by looking at maps, plot maps, aerial photographs, and the like. An aerial photograph with census tracts identified is a very useful tool. A careful tour of the area is a highly-recommended supplement to other data sources.

These data should be carefully organized and recorded for future use.

(C) Explore Boundaries

The census tracts which have been associated with transit requirements are combined into local service areas for demand-responsive transportation. In this step, pay particular attention to:

1. Travel generators;
2. Terrain and street continuity;
3. Area size and shape;
4. Population and population density; and
5. Existing fixed-route services.

Each site should have centers of commercial, health care and industrial development and line-haul transportation access (where possible), as well as residential develop-

USEFUL CENSUS TRACT DATA

- Tract size
- Population density, employment density
- Topographical configuration, including major natural and man-made barriers to travel and social contact.
- Major trip generators (number, location, and type of activity centers)
- Land use patterns (fraction developed, street pattern, residential density, pattern of non-residential use and zoning)
- Socioeconomic characteristics
  - Captive user factors (identify target groups to be served)
  - Distribution of income groups
- Public transportation supply
  - Availability (ratio/square mile; percentage of residents within 1/4 mile access; distance from nodal point and transfer point to line-haul bus routes)
  - Quality (schedules, service frequency, operating hours, route-miles/10,000 population)
- Transit use data for existing services (ridership data in as much detail as available)
- Transit improvement potential and potential for future expansion
  - Total areas may be targeted for complete coverage
  - Other areas may be targeted for partial coverage or selected services

(Source: SYSTAN)

ment. These centers serve as foci for demand-responsive trips, and greatly simplify vehicle routing. Boundaries should not extend beyond geographical or manmade barriers that limit access (e.g., steep hills, rivers, railways, freeways). Similarly, boundaries should not encompass open land and developments that are not accessible from the rest of the site. Sites should be rectangular with a length/width ratio of less than three. Unduly elongated or irregular shapes cause expensive irregularities and should be avoided where possible. The rule and the table to the right give some suggestions for size. Sites should be on one side or the other of a major corridor (e.g., freeway, expressway, heavy rail line) rather than straddling it. Repeated crossing of the corridor can be difficult, dangerous or both. In addition, transfer points at a site boundary are more efficient than internal transfer points. There are several guidelines concerning population and population density (see exhibit). However, experience sometimes defies these guidelines. The best available advice is to review population data carefully and skeptically, and then to proceed with caution.

Existing fixed-route services provide important adjuncts to demand-responsive services; however, they must be used properly. Demand-responsive services should feed fixed-route services; they should not compete with them. Boundaries need to be selected that foster support for fixed-route services. This generally means that fixed-route service should follow service area boundaries.

When tentative boundaries have been selected, it is useful to seek an outside critique from local planners, traffic engineers, and politicians. Their input may prevent later problems.

BOUNDARY SELECTION PROCEDURE

1. Divide the area into logical zones based on land use, geographical, and socioeconomic homogeneity. The size of each zone can vary between 2,000 and 10,000 inhabitants.
2. Locate activity centers, such as public buildings, commercial and industrial plants, shopping centers and recreational areas.
3. Locate existing transportation services, routes and service frequency.
4. Display population characteristics -- look for homogeneity in age distribution, household income, and trip-to-work data.
5. Prepare maps showing proposed zone boundaries, political boundaries, traffic zones, census tracts, geographic barriers, major highways, arterial streets, rail lines, industrial and commercial development. Adjust zone boundaries to minimize disrupting effects of these barriers.

SERVICE AREA SIZE GUIDANCE

General Rules

	Length/width	Desired area
Size Rule: Desired average trip length = 1 to 3 miles	3	2-16 sq.mi.
Average trip length = 1/3 (length + width)	2	2-18 sq.mi.
	1	2-20 sq.mi.

Limiting Ranges

(Dial-A-Ride Systems, in Square Miles)

Terrain or Street Continuity	Urban*		Suburban*		Rural*	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Flat and/or complete grid system	1.0	15.0	3.0	20.0	5.0	30.0
Hilly and/or major street grid with discontinuous local streets	1.0	12.0	3.0	15.0	5.0	20.0
Mountainous and/or limited major through-streets	1.0	10.0	2.0	12.0	5.0	15.0

*Typical population densities: Urban = more than 6,000 persons/square mile
Suburban = 500 to 6,000 persons/square mile
Rural = less than 500 persons/square mile

(Source: Canadian Dial-A-Bus Manual, Reference 4)

(D) Rank Alternative Sites

The purpose of this step is to rank the alternative sites in order of potential for demand-responsive transit services. This allows the planner to consider initial service in those sites having a high probability of success. Additional increments of development can follow successful implementation in the low-risk sites.

The ranking procedure has four steps:

1. Select criteria;
2. Select criteria values;
3. Select criteria weights; and
4. Perform ranking.

The following exhibit illustrates one fairly elaborate dial-a-ride ranking scheme (Reference 4). Simpler schemes are possible and may be just as effective.

(i) Select Criteria. Any ranking scheme needs selection criteria. These may be limited to simple estimates of need, or they may include most or all of the criteria listed in the exhibit. In any case, the list of criteria selected will be a compromise between the desire for completeness and the desire for simplicity.

(ii) Select Criteria Values. The exhibit uses a simple three-point system of criteria values. The three-point system provides comparable measures for each criterion, and prevents one criterion from dominating the selection.

Other, more complex approaches are available. However, it is difficult to justify a more elaborate scheme this early in the planning process.

2.2.6

SITE RANKING PROCEDURE MODEL

VARIABLE	POINTS	DESCRIPTION	REMARKS
POPULATION	1 2 3	Below 4,000 or above 50,000 Between 20,000 and 50,000 Between 4,000 and 20,000	Based on: -Demand-Activated Transportation Systems, HRB Special Report No. 124,1971 -Roos, D.et al., Summary Report - The Dial-a-Ride Transportation Systems, USL TR-70-10, M.I.T., March 1970
DENSITY (persons per square mile)	1 2 3	Below 2,000 or above 10,000 Between 6,000 and 10,000 Between 2,000 and 6,000	-Roos, D., Operational Experience with Demand-Responsive Transportation Systems Research Report R72-2,paper presented at HRB meeting, Washington D.C., Jan. 1972 -Report on Dial-a-Ride Technology Twin Cities Area Metropolitan Transit Commission, TCA MTV-TD-72-01, July 1972 An area with less than 20,000 is initially desirable because low capital investment is needed for implementation a small system is easy to monitor and analyse manual dispatching is adequate
SOCIO-ECONOMIC CHARACTERISTICS Captive user factor	1 2 3	Low proportion of persons aged 5 - 18 or over 65 Higher proportion of persons aged 5 - 18 or over 65 Highest proportion of persons aged between 5 - 18 or over 65	Based on the above and the following reports: -Guenther,K.W.,Summary Report,Phase 1 Results; Ann Arbor Dial-a-Ride Program, FTRPO, 1972 -Guenther, K.W., The Mansfield Dial-a-Ride Experiment, FTRPO, October 1970 1970
Income per household per year	1 2 3	Low to medium income relative areas (under 6,000) High income relative to other areas (over 10,000) Medium to high income relative to other areas (from 6,000 to 10,000)	-Dial-a-Bus, the Bay Ridges Experiment, Ontario Department of Transportation and Communication, August 1971 Note that the income groupings must depend on local conditions.
PUBLIC TRANSPORTATION QUALITY Availability (ratio per square mile)	1 2 3	Highest transit route length High transit route length Low transit route length	This measures the coverage of transit routes. The higher the ratio, the better the coverage. A low ratio means long walking time to transit routes.
Quality	1 2 3	Highest frequency of service at peak hours High frequency of service at peak hours Low frequency of service at peak hours or no transit service at all	This measures the waiting time required for transit service. A low frequency suggests long waiting time.

VARIABLE	POINTS	DESCRIPTION	REMARKS
Distance from nodal point(e.g. rapid transit station,commuter trains or subways) and transfer point to line-haul fixed bus routes	1 2 3	Very close to a nodal point (within walking distance) or farthest away from a nodal point (over 30 minutes round trip) Remote from nodal point but within 20 - 30 minutes round trip Adjacent to nodal point and within 10 - 20 minutes round trip	This measures the efficiency of D.A.B. as a feeder service to rapid transit lines or line haul fixed route bus systems. When the area is very close to the nodal point,people may choose to walk, or when the area is very far from the nodal point, D.A.B. trip time may become too long to be acceptable.
Transit improvement potential	1 2 3	Low potential Medium potential High potential	This measures whether D.A.B. will be an effective tool to increase conventional transit patronage.
INTERNAL TRIP GENERATORS No. of activity centres in service area	1 2 3	Few or no activity centres High number of activity centres Highest number of activity centres	This measures whether there is sufficient transit demand for internal trips.
Employment density (ratio to population)	1 2 3	Low internal employment opportunities High internal employment opportunities Highest internal employment opportunities	This measures the potential demand for internal work trips and inflow of commuter trips from other areas.
Student density (ratio to population)	1 2 3	Low number of local schools High number of local schools Highest number of local schools	This measures the potential demand for internal school trips and inflow of school trips from other areas.
TRANSIT DEMAND PER SQUARE MILE PER HOUR	1 2 3	Less than 10 or over 80 demands 10 - 20 or 60 - 80 demands 20 - 60 demands	Dial-a-Bus is best for demands of 20-60 per square mile per hour. Under 10, the taxi may be a better alternative whereas over 80, fixed route bus is more efficient.

Point 1 = Low potential for Dial-a-Ride
2 = Moderate potential
3 = High potential

(Source: Canadian Dial-A-Ride Manual, Reference 4)

(iii) Criterion Weights. Serious problems are posed by criterion weights. Clearly, site population is not as important as the number of captive riders in the site. However, what does "not as important" mean? Should captive riders be weighted twice as heavily as population? No one is sure. Several schemes have been proposed for establishing criterion weights (Reference 49). However, at this stage a simple scheme should be followed. The procedure in the table uses equal weights for all criteria.

(iv) Perform Ranking. Once criteria, ratings and weights have been selected, generating the rankings is a purely mechanical process:

1. Rate each criterion for each site;
2. Multiply each criterion rating by its weight;
3. Sum the rate-weight products for each site; and
4. List all sites in descending order of rate-weight sums.

The first site on the list is the preferred site. The next site is second, and so forth. The top site need not be selected first, but the decisionmaker should be aware of the site rankings.

(E) General Observations on Site Selection

While the point-ranking system suggested in the Canadian Manual properly ranks the relative suitability of sites, the experience reflected by the 78 general market systems described in the Service Characteristics section suggest that systems can succeed in areas that would be ranked low in several criteria. For example, only 38% of the general market systems are in the ideal range for population density of 2,000 to 6,000 persons per square mile; 50% are in the lowest category of less than 2,000 or more than 10,000. None of the 71 reporting general market dial-a-bus systems have a demand density in the ideal range of 20 to 60 passengers per square mile per hour. Ninety-nine percent of all general market systems have demand densities in the lowest range of less than ten demands per square mile per hour. In general, these site-rating systems are useful for ranking alternative sites, but they do not necessarily identify which sites will be successful.

It is a common feeling among practitioners that service area boundaries are determined by budget, citizen input, the political process, and travel patterns rather than by political boundaries; thus, local systems may not in fact offer full coverage to a city.

The service areas of general market systems have varied from 1.6 square miles (Davison, Michigan) to 3,373 square miles (Eastern Upper Peninsula, Michigan) in those general market services operating within a single zone. Thirty-eight percent of these systems' service areas were between four and eight square miles.

The characteristics of other communities with paratransit services are included in Appendix 4. Similar local characteristics may suggest criteria to emphasize in local planning efforts.

A high-income neighborhood may be attracted only to extremely high service levels, while transit-dependent areas may respond well to more limited service.

Go to
APPENDIX A-4
Community System
Summary Sheets

2.2.7

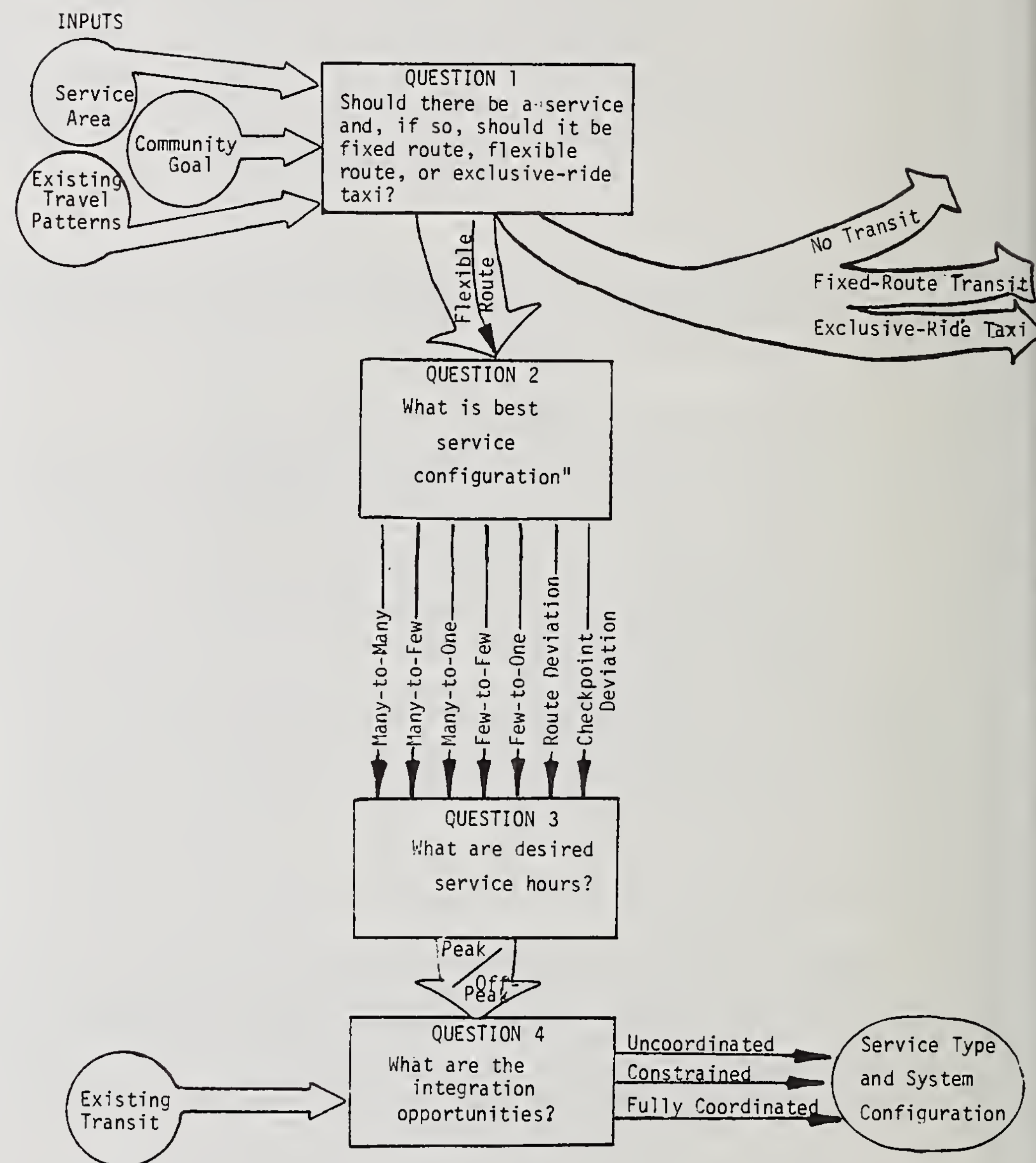
2.2.7 Selecting a Service Type

Selecting an appropriate type of service and laying out the system configuration need not require extensive and expensive investigations. The body of past experience with conventional transit and paratransit systems can be assembled to produce a logical set of guidelines. The logical structure followed in this section and the subsequent section on configuration planning is illustrated at the right. This structure consists of a series of four questions or decisions that eliminate unattractive options and devote greater attention to a shrinking number of attractive ones. The four questions deal successively with the type of service, the service configuration, the hours of operation, and integration opportunities. These four questions may be posed for both general market and target market services, although the guidance for selecting a service type and planning the system configuration may be slightly different in each case.

The first question to be addressed entails the selection of a service type. This selection process requires a broad knowledge of service area characteristics, community goals, and existing travel patterns. Certain decisions will also be aided by rough estimates of the level of demand likely to be carried on the system (see Section 2.2.10). At the broadest level, the question of service type focuses on the choice between shared-ride paratransit and the following three options:

- Conventional fixed-route transit;
- Exclusive-ride taxi; and
- No transit service.

SERVICE OPTION
IDENTIFICATION STRUCTURE



Source: SYSTAN

2.2.10(A)
Rough Estimates of Demand

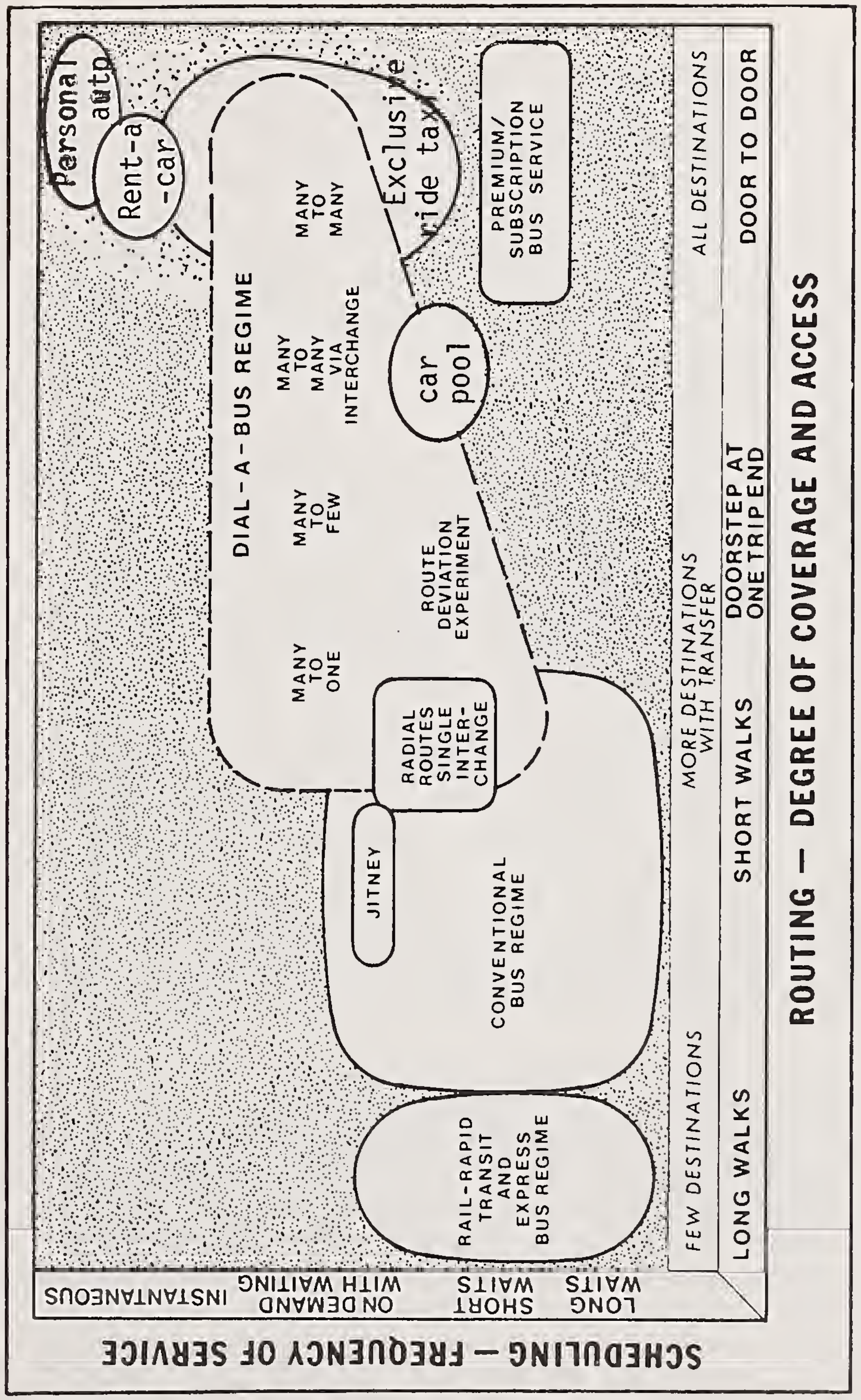
The accompanying exhibit shows the potential application areas for different transportation services expressed in terms of service frequency (expected wait) and accessibility (expected walk). Paratransit services typically fall between the two alternatives of conventional transit and exclusive-ride taxi, supplying more accessible, more frequent service than conventional transit, without equalling the exclusive-ride taxi.

(A) The Choice of Paratransit or Conventional Transit

Conventional fixed-route transit services and flexibly-routed paratransit services have distinctly different characteristics, and certain general observations may be made regarding the relative suitability of these characteristics in specific settings. Although there are few foolproof rules for selecting paratransit over conventional transit, or vice versa, a consideration of the following factors may help to guide the choice:

- The needs of potential users;
- Service area characteristics;
- System costs and productivity; and
- Anticipated demand levels.

(i) The Needs of Potential Users. In spite of the uncertainties about behavioral response to either fixed-route or paratransit, there are some general guidelines for choosing between the two services. The first factors that should be considered are the intrinsic differences in the services as they relate to the perceived needs of the potential users. Paratransit services are basically more convenient than conventional transit services, since their pick-up points and times are tailored to demand. Because paratransit routes and schedules must be flexible



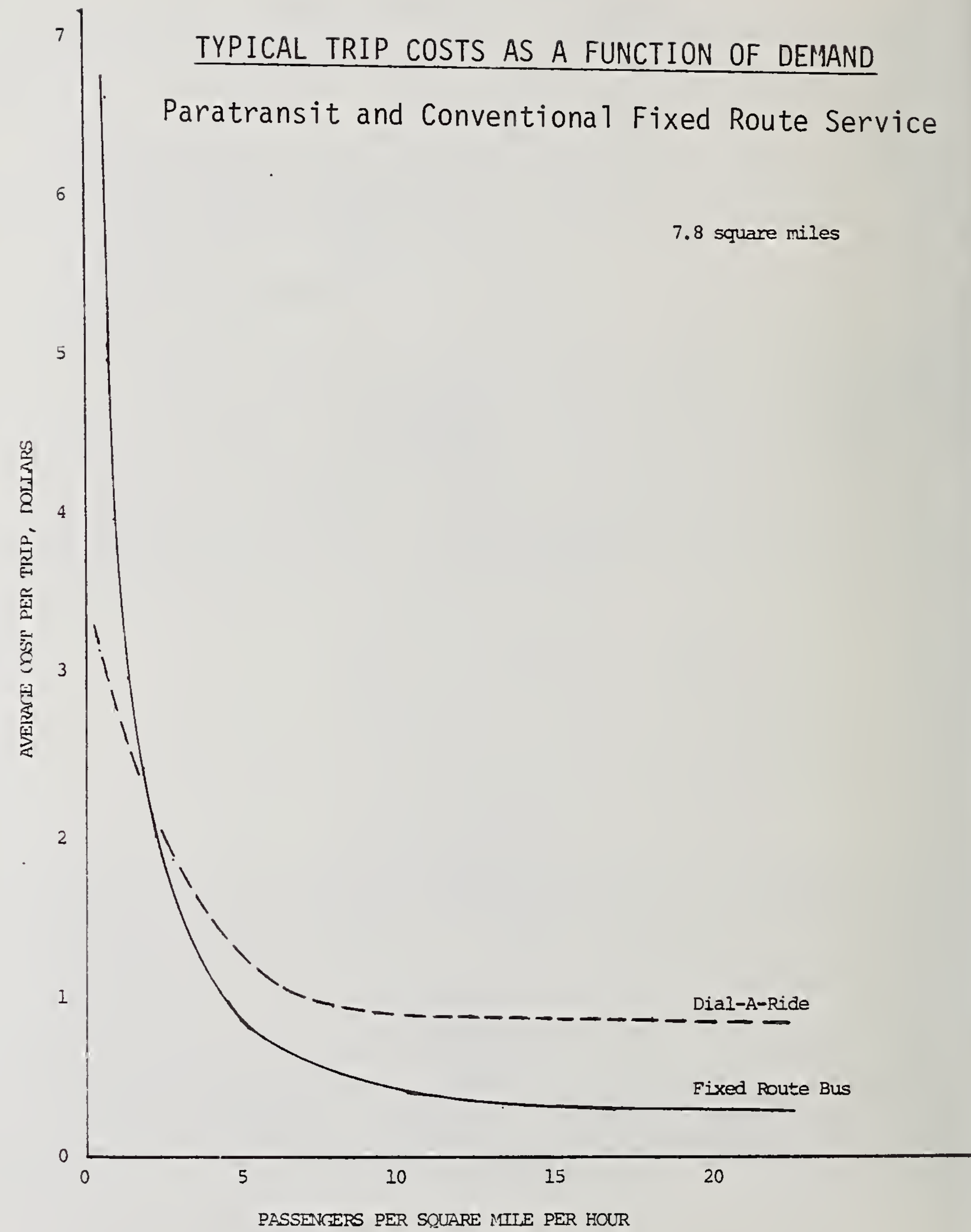
CONCEPTUAL FRAMEWORK FOR DAB SERVICES

(Source: Adapted from State-of-the-Art Overview, Reference 7) enough to be demand-responsive, they will generally be less reliable than fixed-route buses operating on a schedule of predictable pick-up and arrival times. Thus, the choice between paratransit and fixed-route transit may reflect a choice between convenience and predictability. For some users, such as the elderly and handicapped, the convenience of door-to-door service may be necessary, while schedule predictability may be essential to other users, such as commuters, who have to be in a particular place at a fixed time.

Certain forms of paratransit service are more reliable than others. Pre-arranged subscription service, for example, can be just as reliable as fixed-route bus service and may be an appropriate choice for serving a commuter market. Demand-responsive dial-a-ride systems may also be operated with an acceptable degree of reliability, but such an operation requires careful design, training, and operational debugging.

(ii) Service Area Characteristics. If residential areas are non-uniform, street patterns are irregular and the service area is about square, flexible-route service may be preferred. However, if one or more development corridors can be identified, there may be an opportunity for fixed-route service. In opting for fixed-route bus service, there should be an opportunity to fill at least four buses per day on each potential route. Even this volume is marginal.

(iii) System Costs and Productivity. In areas of high demand density, the productivity of fixed-route service (measured in terms of passengers carried per vehicle-hour) is significantly higher than that of paratransit service. Consequently, the per-passenger cost of providing the service is proportionally lower. The accompanying exhibit plots typical fixed-route and paratransit systems costs over a range of demand densities. The cost of fixed-route service is relatively high for low levels of demand, and drops to a relatively constant level once a minimum service level is exceeded and buses run at capacity. Since flexibly-routed service can be tailored to



Source: SYSTAN

fit any demand level, paratransit service is less costly at low demand levels than fixed-route service. As demand increases, however, fixed-route service becomes less costly than flexibly-routed service. The demand level at which this crossover occurs is governed by a number of factors, including service area size; population density; minimum service levels; peak/off-peak demand patterns; the timing, orientation and length of the trips served; and transit union constraints. Theoretically, if prospective demand densities are less than about ten demands per square mile per hour, dial-a-ride service is less costly than fixed-route service on a per-passenger demand basis, so long as other costs are comparable. When demands are between ten and eighty demands per square mile per hour, the relative cost-effectiveness of fixed- and flexible-route services will depend on other factors. If land use patterns and travel patterns suggest that the demand is concentrated in travel corridors, fixed-route service may be preferable, even at lower densities.

Although the specific levels of the cost characteristics depend on a large number of factors, the general behavior of the fixed- and flexible-route curves shown in the accompanying exhibit is typical. Flexible-route service enjoys the greatest cost advantages for low demand levels in the less densely-populated areas of a region. In higher demand density areas, the number of passengers per vehicle-hour will be lower for paratransit than for transit, and the unit costs of paratransit higher, if operating costs are comparable. Costs are not always comparable, as many paratransit systems are operated with lower than union scale wage rates under flexible work rules which allow part-time drivers and permit the supply of buses to adjust to the peaking of demand throughout the day. Therefore, paratransit systems may operate at comparable or lower costs than fixed-route, even in fairly high demand density areas. As demand levels increase, however, some demand-responsive runs should evolve into fixed-route service. Experience suggests that the evolution process should be a gradual one, since public response has been poor when one type of service has abruptly replaced another. This suggests that, where demand permits, both fixed- and flexible-route service might be offered within the same area during any transition phase.

A good deal of judgment needs to be applied in interpreting the crossover point shown in the typical cost chart. At low transit mode shares, flexible-route service is considerably less risky than fixed-route service. That is, the cost of providing fixed-route service for a demand that fails to materialize can be considerably higher than the cost of providing flexible-route service sized to fit whatever demand exists. If demand does materialize, moreover, there is an upper bound on the per-trip savings available from conventional fixed-route operations. This suggests that an incremental approach that uses flexible-route service might be a more appropriate means of introducing transit service in a currently-unserved area, even if it is expected that the area demand will be large enough to justify fixed-route service. Moreover, a dial-a-ride system often has an implementation advantage when new service is provided in areas with little or no history of transit service, as demand for dial-a-ride service usually develops more quickly than demand for more conventional fixed-route systems.

<u>(iv) Daily Demand</u>. As a rough rule of thumb, if the estimated demand for the service area exceeds 500 passengers per day, the area is a candidate for fixed-route bus service. This rule works reasonably well if the service area is less than 25 square miles in size.

<u>(v) Additional Considerations</u>. A recent review of dial-a-ride operating characteristics suggests that there are at least two major areas where dial-a-ride is inferior to fixed-route service even for low-density service areas: "In the first instance, an area with some existing fixed-route service will typically have developed a hard core of bus riders who use the routed system knowledgably, and for whom it is well suited. They will be highly resistant to changes in that service, and will often regard dial-a-ride as an inferior

substitute, even if it allows them service to a broader mix of destinations. Accustomed to waiting at a bus stop at known times, they will be unwilling to request service by telephone. While they will normally be counterbalanced by a much larger number of dial-a-ride users who had not previously ridden the routed service, they will complain loudly.

Secondly, without special design elements such as zones with external destinations, hierarchical subsystems, and combinations with fixed-route service, long trips will be poorly served by dial-a-ride. By its very nature, dial-a-ride is circuitously routed. It should not be expected to serve trips of longer than three to four miles (line of sight) in suburban areas without such features" (Reference 61).

For many service areas, the choice between fixed-route or flexible-route service will be a close one. In these situations, the planner should consider the potential impact of future growth and development and the likelihood of economic changes in the service area. Fixed-route service should not be selected if its feasibility depends on substantial increases in population growth and transit demand (e.g., increases of 20 percent or more) over a short time horizon.

The accompanying illustration summarizes the comparative features of paratransit and fixed-route services.

(B) Shared-Ride Paratransit Versus Exclusive-Ride Taxi.

As demand densities increase, paratransit modes should evolve into fixed-route transit systems, or integrated combinations of fixed-route and demand-responsive systems. At the other end of the spectrum, for very low demand densities, the service provided by shared-ride demand-responsive service becomes indistinguishable from that provided by exclusive-ride taxis. If there are not enough riders to provide ride-sharing opportunities, paratransit vehicle productivity will clearly be no different from that of conventional taxi service. So long as the

FLEXIBLE VS. FIXED-ROUTE SERVICE APPLICABILITY

(Comparing Systems With the Same Overall Service Level Over the Same Area)

Feature	Flexible-Route	Fixed-Route
Cost	Better comparative performance in low-density areas.	Better performance in high-density areas.
Trips Served	Best for scattered local trips.	Best for long trips in corridors.
Riders Served	Draws varied patronage, many elderly and young, misc. trip types.	Primarily commuter oriented.
Peaking Behavior	Often shows midday peaking.	Morning and afternoon work trip peaks.
Ridership Growth	Usually shows fast growth.	Often takes many months to develop patronage.
Reliability	Weak point, needs careful and constant attention.	Easier to maintain planned service quality.
Coverage	Available equally to all service area points.	Different residences and businesses are nearer or farther from routes.

(Source: SEMTA, Reference 61)

costs of shared-ride paratransit service and exclusive-ride taxi service are comparable, as is the case in most existing low-density systems, the choice between the two forms of service will be marginal at very low demand levels (i.e., under two demands per square mile per hour). If transit union wage scales or work rules cause shared-ride service to be significantly more expensive than exclusive-ride taxi operations, taxi service becomes the clear choice in sparsely populated areas. The wider the range between shared-ride and exclusive-ride service, the higher the demand densities needed to justify shared-ride service. In areas of low demand density in which shared-ride services are significantly more expensive than conventional taxi services, therefore, certain social aims -- such as mobility for the elderly and handicapped -- can best be met by providing members of the target population with subsidized rides in local taxis.

(C) Paratransit Versus No Transit

Improved transit service is but one of the means available for addressing the wide range of community goals commonly cited in plans for new transit or paratransit services. These goals typically include a desire for increased accessibility to community services; improved mobility for the elderly and handicapped; and reduced congestion, air pollution, and energy consumption. These goals can often be approached by steps outside the transit planning process. Policymakers and planners should balance transit approaches against non-transit measures early in the planning process. Although many goals seem to point naturally to a transit solution, closer and more creative consideration may reveal cost-effective approaches outside the realm of transit and paratransit networks.

Examples of non-transit approaches to community transportation goals include the introduction of flexible working hours to relieve peak-hour congestion; the use of bookmobiles and mobile health care units to make community services more available to the elderly and handicapped; and increased reliance on mail services, goods transport services, and public communications systems to replace many of the personal trips now made to obtain information, pay bills, and register for social services.

2.2.8 Planning the System Configuration

If a paratransit system is selected as one of the options to be pursued in the planning process, several questions regarding the system configuration remain to be addressed. These include the nature of the service, the hours of operation, and opportunities for integration with adjacent transit systems.

(A) The Nature of the Service

The planner of a paratransit system has several service options available to him. These include:

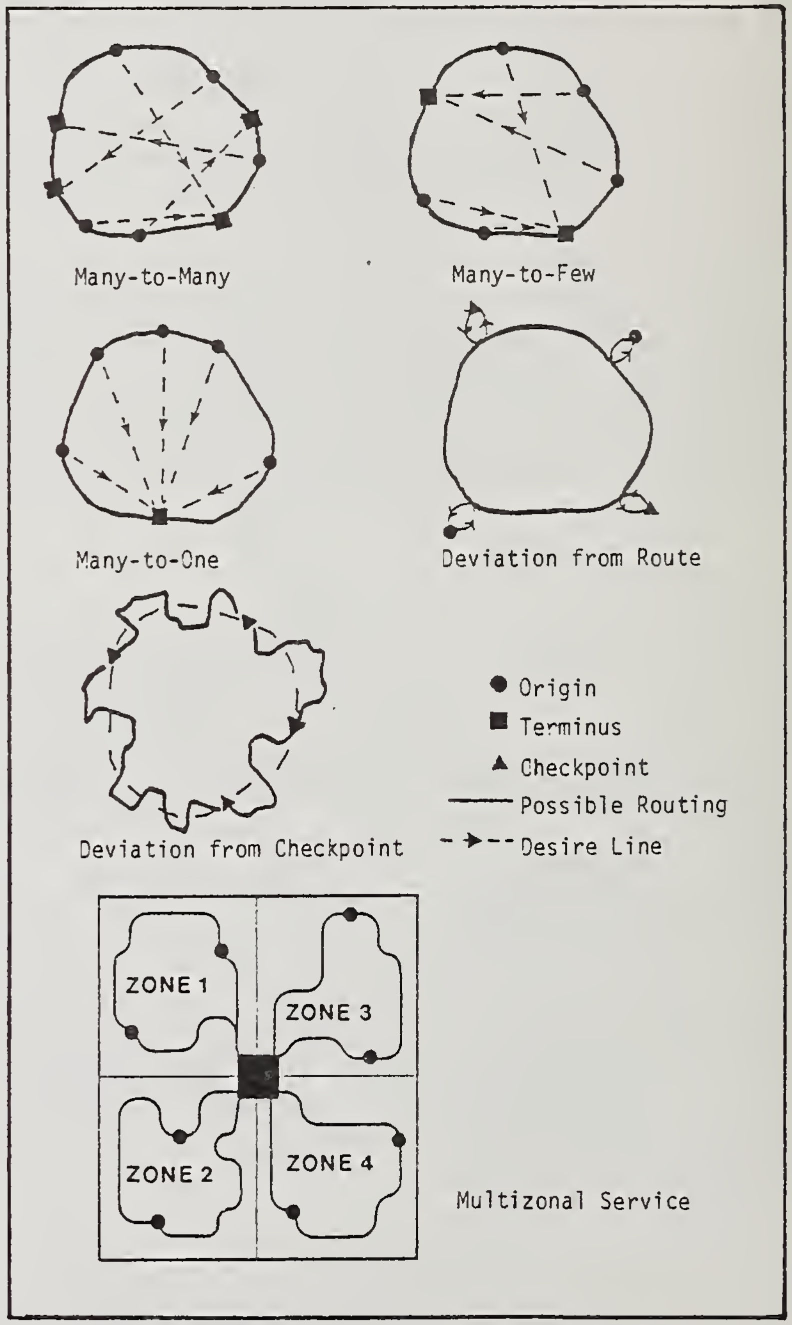
- o Many-to-many;
- o Many-to-few;
- o Many-to-one;
- o Route deviation; and
- o Checkpoint deviation.

These options are defined in the Introduction (Part 1). Different options may be offered during peak and off-peak periods, and any of the above options may provide doorstop service, limited doorstop service (i.e., door-to-door service for the handicapped only), or checkpoint service. Service to pre-selected checkpoints may more properly be termed "few-to-few" or "few-to-one" service.

Other options available to the planner include:

- o Multi-zonal service, which permits the extension of paratransit service to broader areas, often with the inconvenience of a transfer.

Go to Part 1, Introduction
Section 3.0
What Paratransit Is



(Source: SYSTAN and SEMTA, Reference 61)

- Special service options (generally a form of target market service), including:
  - Elderly and handicapped service;
  - Childrens' day care service;
  - Shoppers' special service for the transit-dependent;
  - Stop-and-shop service to supplement home-to-work subscription service; and
  - Special low-income service.
- Ancillary options:
  - Package delivery;
  - Delivery of mail from post office boxes to business firms and local institutions;
  - Transfer of business data among branch banks;
  - Transportation of blood and other hospital supplies;
  - Retailer-sponsored shopping services;
  - School transportation; and
  - Bar-to-home service for tavern patrons.

The planner should consider all seven service configurations for his service area. He will probably elect to carry the two or three most promising configurations forward for further analysis.

(i) Route-Based Service Versus Unconstrained Routing. Two of the options available to the paratransit planner are route-based:

- Route deviation; and
- Checkpoint deviation.

Many of the considerations advanced earlier in comparing paratransit service and fixed-route service apply equally well in comparing route-based paratransit service with less constrained service options (see Section 2.2.7(A)). Route-based options are generally considered as modifications to existing fixed-route services. If there is no existing service, only non-route-based options need to be explored. An exception occurs when the service area is particularly suited to route-based services (e.g., long and narrow).

(ii) How Many to How Many? In the planning phase, service configurations are generally selected on the basis of service area characteristics. The existing patterns of trips between residences and commercial, business, health, government and other activity centers can guide the selection of many-to-many, many-to-few, or many-to-one service. Very few trips occur between residences. The choice of service depends on the nature and distribution of the activity centers within the service area. If there are activity centers scattered throughout the service area, many-to-many service may be preferred. If the activity centers are concentrated or dominated by one or a few locations, then many-to-one or many-to-few service may be the answer.

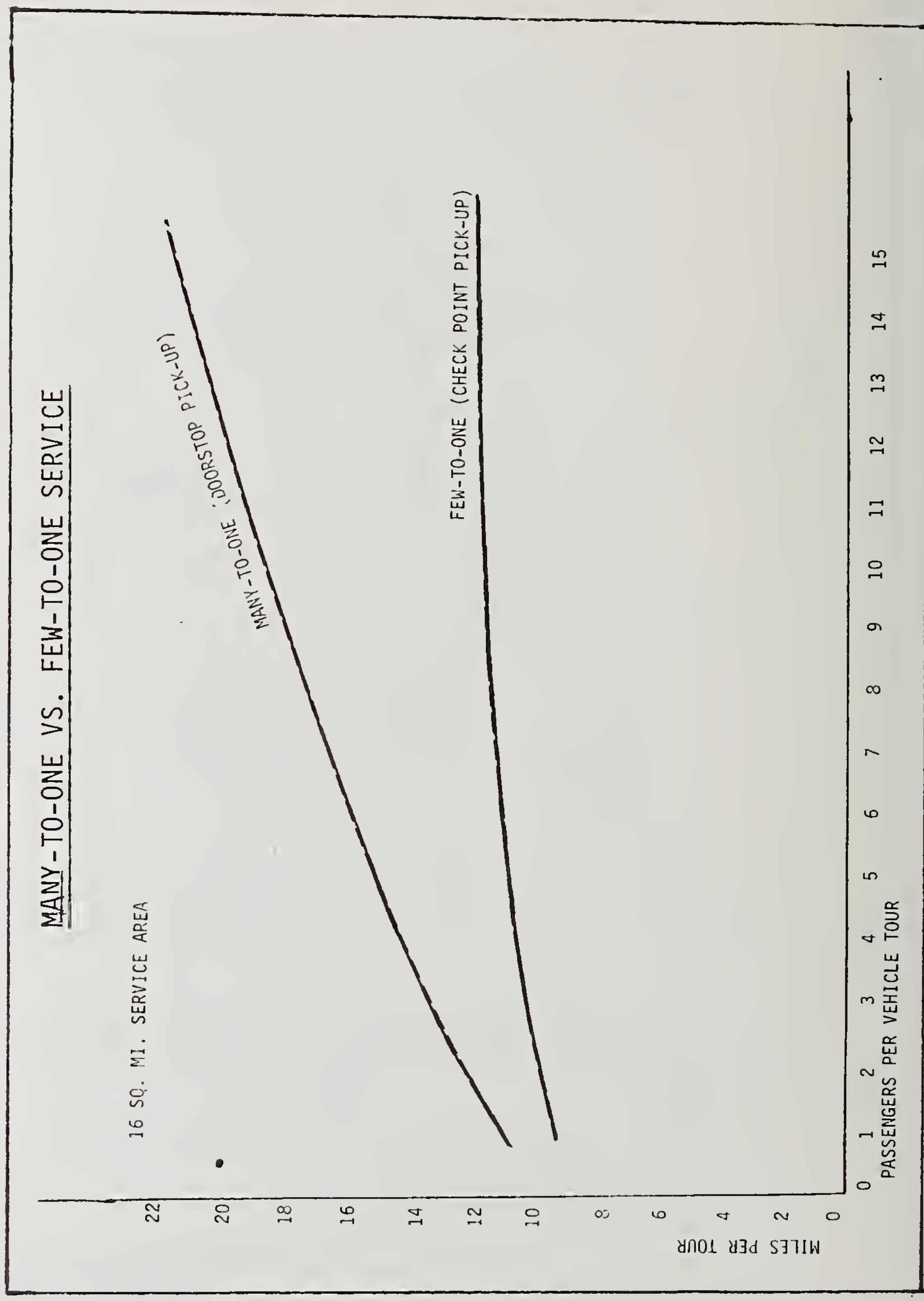
Most existing paratransit systems offer many-to-many service. Roughly 90% of all general market systems surveyed and 70% of all target market systems characterized themselves in this fashion. As a practical matter, however, the prevailing pattern of trips in most systems can be characterized as many-to-few; that is, a limited number of destinations dominate the travel choices of most paratransit riders.

2.2.7(A)
Paratransit Versus
Conventional Transit

2.2.8

(iii) Doorstop Service Versus Checkpoint Service. The planner can also choose between doorstop and checkpoint services. Checkpoint service is more efficient in the use of driver and vehicle time, but it accomplishes this at the expense of passenger time and inconvenience. Checkpoint service is useful where street patterns are excessively complex and where the service area contains apartment and condominium complexes providing many residents with easy access to a single boarding point. The accompanying chart shows the relationship between typical tour distances for many-to-one (doorstop pick-up) and few-to-one (checkpoint pick-up) service. For small numbers of passengers per vehicle tour, the checkpoint service benefits from easy access to checkpoints. Checkpoints are selected for convenience as well as accessibility; however, the many-to-one service must go to the passenger's door. As the number of passengers per tour increases, the checkpoint service benefits from being able to pick up more than one passenger at many stops. Remember, most vehicles pick up no more than seven or eight passengers per tour. Merrill, Wisconsin has had some success in using a fare incentive to encourage passengers to use checkpoints.

CAUTION: Beware of selecting checkpoints to serve low-income housing areas. For safety reasons, many residents will not leave their homes unless they can see the transit vehicle.



(Source: SYSTAN)

(B) Service Hours

When planning a new service, some of the key issues are:

1. What should the operating hours be?

2. Should the same configuration be used during both peak and off-peak periods (e.g., many-to-one peak period, many-to-many off-peak)?

3. Should the same level of service be provided during peak and off-peak periods?

4. Are other uses available for vehicles during non-operating hours?

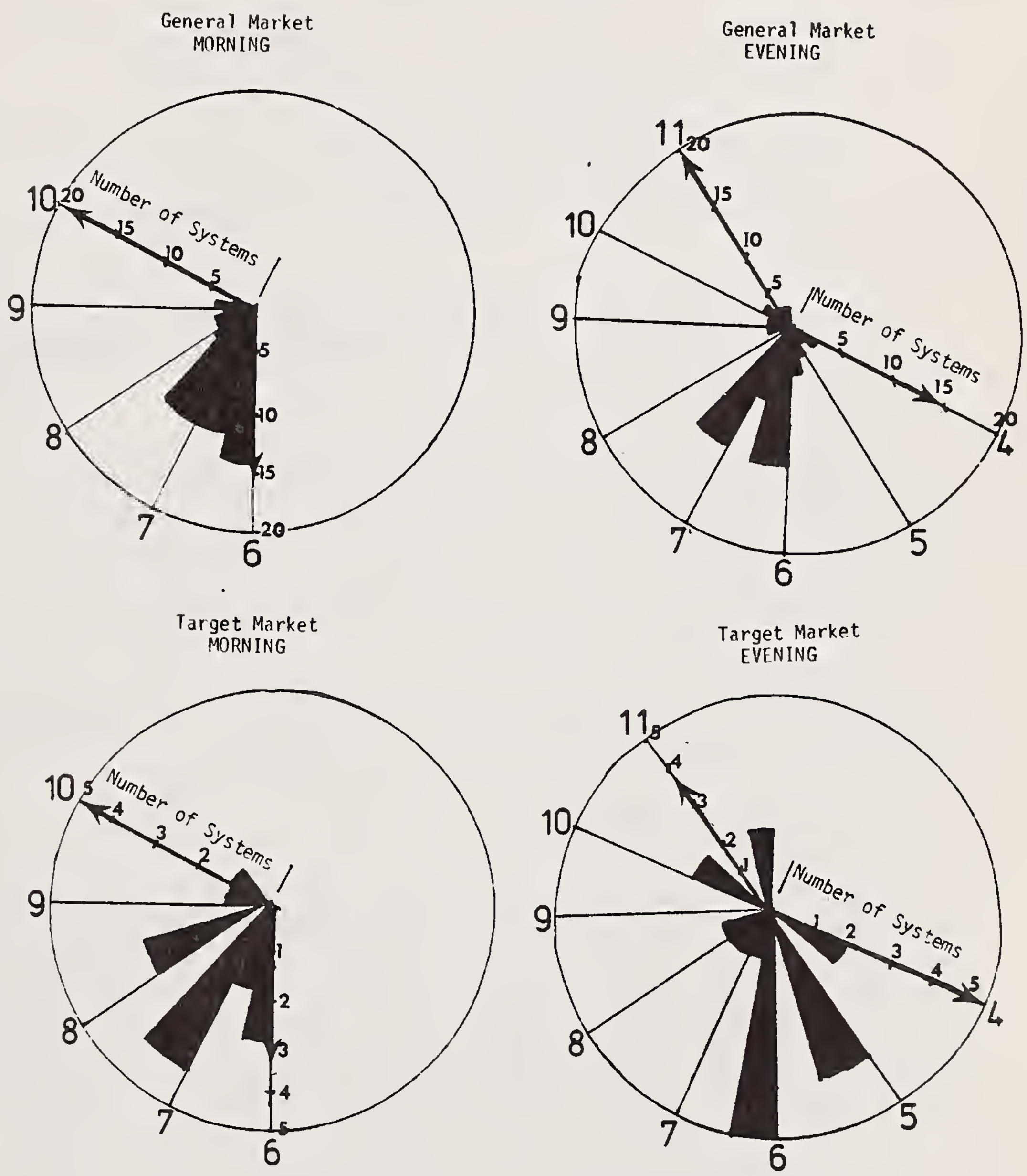
5. Are drivers fully used? Is time paid for actually productive?

Each issue needs to be studied in a site-specific setting.

Existing demand-responsive systems concentrate service during the day (see exhibit), usually serving part of one or both peak demand periods.

During the early planning stages, the planner may wish to select a simple set of operating hours. More detailed study is appropriate during the design phase. Simple options may include:

- o Off-peak operation only between 10:00 A.M. and 4:00 P.M. with drivers performing one subscription peak-hour trip before and after normal services.



(Source: SYSTAN)

- Off-peak operation only, using vanpool vehicles that are driven to and from work by others.
- Operation between 8:00 A.M. and 5:00 P.M. with one shift; peak-hour many-to-one services to line-haul station; off-peak many-to-many service.
- Twelve hours of operation with part-time labor in the evening. Any combination of peak and off-peak services.

The above representations are based on uniform supply throughout the operating period. Additional options are available that would provide more service during peak periods and less during evening hours. These options introduce labor-scheduling problems which, in the absence of part-time labor, may result in expensive idle time.

There is no prescribed procedure for reviewing optional service hours. The planner should consider the needs and resources of each service area individually.

(C) Integration Options

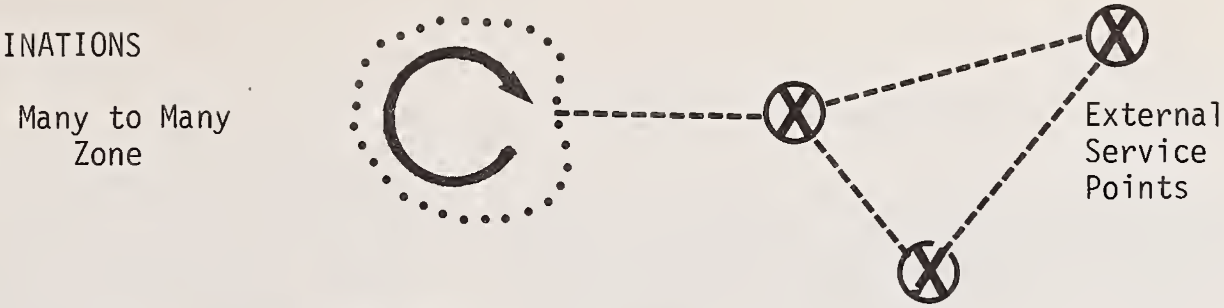
The last question in planning a paratransit service concerns integration. How can and should transportation services in different areas fit together to complement one another? Several integration strategies are available to help coordinate demand-responsive services with one another and with conventional transit services. Coordination requirements are both temporal and spatial.

(i) Temporal Coordination Strategies.

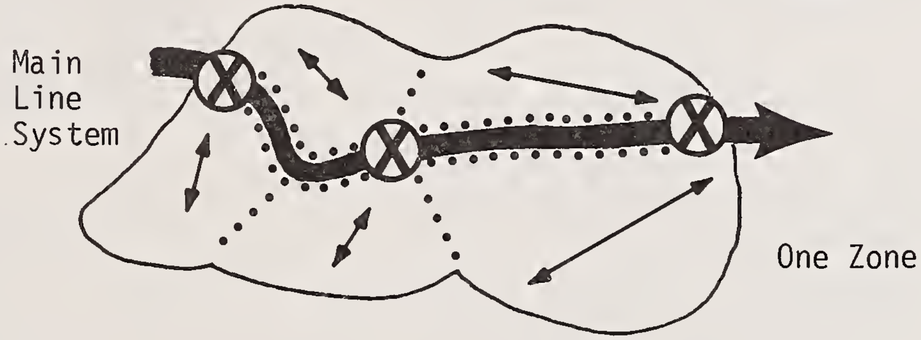
- Uncoordinated Services: Each leg of a trip is optimized independently. This approach simplifies the control problem, but at the expense of effectiveness of service provided. Transfer facility must be very comfortable. In general, transfer facilities should provide protection from the elements, be secure, and provide a means of access to system information.
- Constrained Paratransit Services: Paratransit services are operated on a semi-scheduled basis with scheduled rendezvous at transfer points. Reduces real-time control burden; makes service more predictable from user's viewpoint. Under this basic approach, paratransit service areas are typically divided into zones which can be integrated with fixed-route line-haul services or with other paratransit zones.
- Fully-Coordinated Services: Total trips are optimized, with explicit attempts to minimize transfer times. Heavy real-time control burden is imposed; computer control may be advisable in complex integration situations.

(ii) Spatial Coordination Strategies. Several spatial integration strategies are illustrated. In some instances, demand-responsive services can be extended outside the service area to external activity centers. In other instances, demand-responsive services can provide collection and distribution for a line-haul service, or several demand-responsive services might join together at a common transfer point. It may be desirable to superimpose an interarea demand-responsive service to serve long trips that cross service area boundaries and cannot be

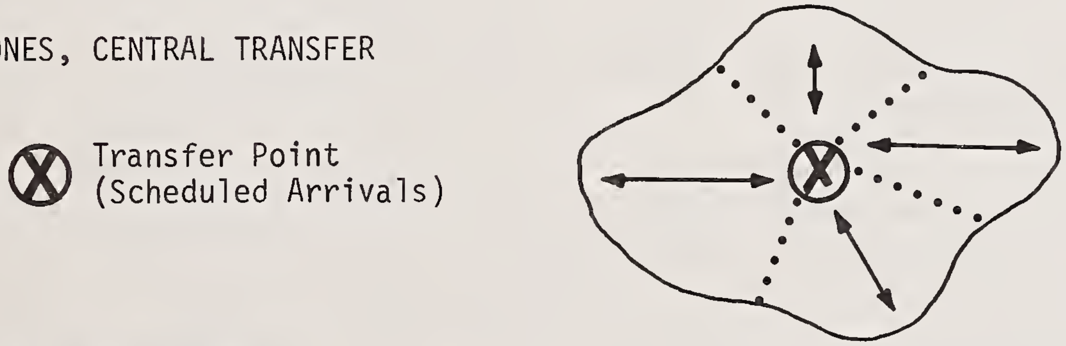
EXTERNAL DESTINATIONS



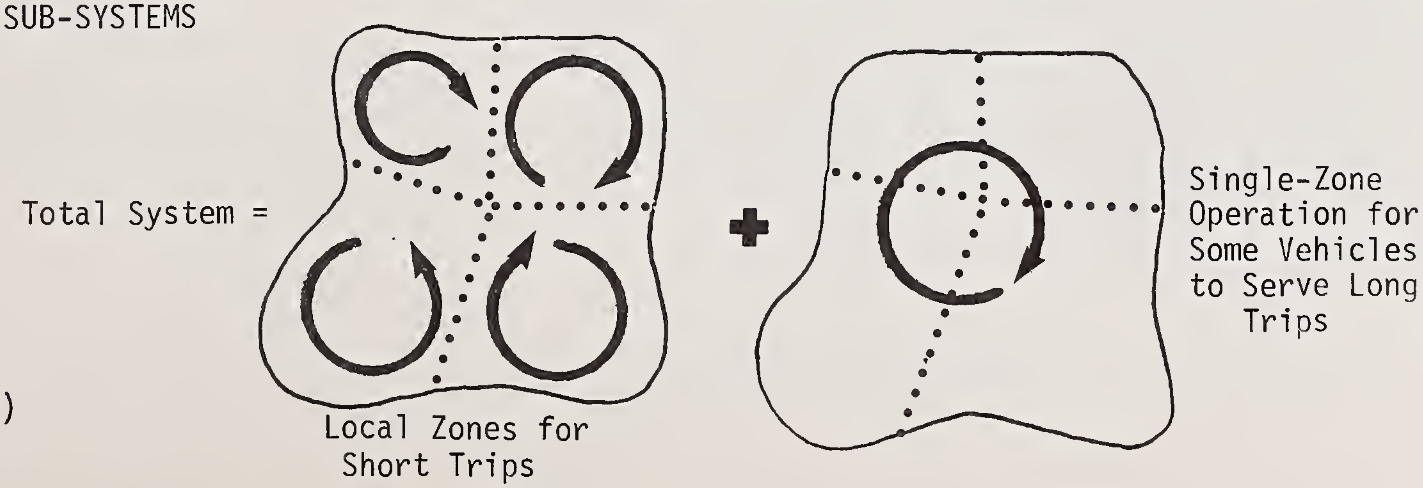
FEEDER OPERATION TO
DIFFERENT MODE



RADIAL ZONES, CENTRAL TRANSFER



HIERARCHICAL SUB-SYSTEMS



(Source: SEMTA, Reference 61)

conveniently accommodated by transfers between intra-area services.

(iii) Planning for Integration. Integration planning begins by postulating all of the different kinds of trips, as classified in the accompanying exhibit, in terms of trip type, trip path and trip frequency.

Integration is generally concerned only with inter-zonal trips. When considering a set of possible trips, it is useful to select a specific origin and a specific destination for each trip. Next, postulate two or more alternative means of accomplishing each trip. Note all transfers between services that occur. Establish requirements for each transfer in terms of time of day, wait time, walk, etc. Optional trips may depend on good transfer conditions. A study of all sample trips will yield a set of integration requirements.

Service characteristics are next examined to determine whether coordination requirements can be met. Some demand-responsive services are more amenable to scheduling than others. It is not likely that all integration requirements can be met. Some trip types will need to be passed over. This is not a basis for rejecting a service option, but it will limit the market that the option can serve.

The product of the system configuration planning process is a small number of options that appear to be attractive for each service area under study. In all instances, more than one option should be considered, but in most cases, the number of candidates should not exceed three. The final options package should be tied together with two or more integration schemes.

CANDIDATE TRIPS USING DEMAND-RESPONSIVE SERVICES

Trip Types

- Work trips
- Personal business trips
- Shopping trips
- Recreational trips
- Social trips

Trip Paths

- Intrazonal
- Interzonal

Trip Frequency

- Daily
- Weekly
- Occasional

(Source: SYSTAN)

2.2.9 Identify Fare Policy

Determining a fare policy during the planning stage requires some skillful juggling of capital and operating costs among the passengers, the local community, and available funding sources. More detailed issues, such as the fare structure itself and fare collection techniques, should not be a concern at this time. They will be adequately covered during the design phase. Fare policy planning focuses on:

(A) Determining constraints;
(B) Formulating alternatives; and
(C) Evaluating alternatives.

(A) Determining Fare Policy Constraints

Before fare policies can even be considered, the ground rules must be identified and thoroughly understood. The first step is to review the financial aid that is available for the service. Section 2.2.5 provides general guidelines. More information is available from COG, State and UMTA sources. It may also be appropriate to approach social welfare agencies to see whether their clients might use the new services and whether the agencies will subsidize this use. In fiscal year 1976, the Departments of HEW, HUD, Interior and Labor provided over $200 million for the transportation of people in support of department programs.

Review policies, regulations, and institutional issues. Some of these are relatively straightforward (e.g., senior citizen fares); others are very complex (e.g., Section 13(c)). Check local taxi ordinances to guard against encroaching on local operators' rights.

2.2.5
Funding

FARE POLICY CONSTRAINTS

- Funding support availability (subsidies)
  - Federal
  - State
  - Local
- Policies, regulations, and institutional issues concern fares; identify potential conflicts at federal, state and local levels. (Do franchise requirements conflict with shared-ride structure regulations?)
- Fare objectives
  - How much of the cost should be covered?
  - Should fares of specific target groups be subsidized?
  - What recovery requirements are imposed by sources or approvers of funding?
- Determine level of service desired
  - Can community afford to subsidize system to meet service objectives?
  - Or can institututional constraints and service objectives be compromised?
  - When considering fare policy vis a vis service options, remember that ridership levels appear to be more sensitive to service conditions than to fares (i.e., because it is more personal, paratransit service may be as attractive to riders as conventional bus service, despite higher fares)
- Relate proposed fare policy to existing transit and taxi system fares.

(Source: SYSTAN)

2.2.9

Help is available at the state and federal levels; most states have a Department of Transportation office which can aid and inform public transportation programs.

Establish the objectives and limitations for fares. City councils are concerned with the size of the subsidies they pay to support local transit; some of these subsidies may need to be divided among existing and new services. It is wise to face the issue of local support clearly at this time, rather than to face severe service curtailment at a later date. City council members can advise you on this issue.

At this point, it is possible to begin structuring a fare policy. Capital and operating costs can be estimated (see Section 2.2.11) as well as the subsidies needed. The remaining cost must come from the farebox--a number of possibilities exist through various combinations of patronage and fares. Fares for other local transportation services provide useful benchmarks. If fare requirements are substantially larger than the going rate, the plan should be carefully reviewed. Similarly, if reasonable fares encourage voluminous patronage and vehicle demand, the plan needs careful revision.

(B) Formulate Fare Policy Alternatives

There are a variety of different fare policies designed to fit almost any community's requirements (see exhibit). The planner's imagination is challenged to find variations or combinations of these policies that better suit his community's particular needs. Special

2.2.12
Estimating Costs
and Revenues

P

FARE POLICY ALTERNATIVES

POLICIES	DESCRIPTION/ DEFINITION	ADVANTAGES	DISADVANTAGES	COMMENTS
Cost-Recovery	Each route or service supports its own total costs	- Eliminate deficits - Efficient - Potential for complete cost recovery	- Target market groups - Not feasible to recover each service's cost - Each area receives different service levels and quality	- Different areas receive different service levels - Some areas may be taxed without receiving service - Only profitable services are retained - May eliminate all service
Cross-Subsidization	Offsetting the deficits incurred from one service with the profits from another service or route within the system	- More flexible than cost-recovery - Encourages coordination/integration of services - Efficient - Potential for complete cost recovery	- May not be feasible to cover all system costs - May not achieve community's social objectives - Limits type and quality of service	- Vast majority of existing paratransit systems fail to break even.
Community Service	Providing subsidies in order to attain certain social objectives or induce ridership	- Equitable - Increase paratransit service level and quality - Achieve community objectives - Provide service to target market that would otherwise be too costly	- Inefficient - Increase cost to community	- It may use out-of-pocket automobile costs as a standard for comparison.
Value of Service	Relates fares to what user feels service is worth compared to other sorts of purchases	- Equitable: fares reflect the value of service - Transit is established as worthwhile commodity	- Subjective valuation - Impractical	Relative worth of buying transit service as compared to other purchases that could be made with same outlay; compares with competing modes.
Combination	Different policies applied to different services or system users (i.e., provide subsidized fares to target markets and set general market fares according to value of service.	- Flexible to meet needs of users - Achieve community objectives - Equitable - Efficient	- Complicates fare structure and collection	

(Source: SYSTAN)

fares can be adopted for target markets. Variations in time of day can be explored. Different fares can be set for different trip combinations. Above all else, however, the planner is cautioned to KEEP IT SIMPLE!

(C) Evaluate Alternative Fare Policies

In recent years, subsidies have become a necessary and accepted aspect of public transit financing. In 1975, half of the operating costs of the public transit industry came from non-transit revenue. Few existing paratransit systems operate on a pay-as-you-go basis. Communities are becoming increasingly aware that increased transit use can benefit the entire community through improved mobility, reduced congestion, reduced pollution, and other social improvements. Demand-responsive services can contribute to these improvements. Therefore, the planner need not apologize for a subsidized fare policy. He will, however, need to convince the council that the size of the potential subsidy is justifiable.

Selecting and evaluating fare policy alternatives is an "iffy" business. Fare levels affect ridership, which in turn influences operating costs. To evaluate fare policies thoroughly, the planner should estimate the impact of fares on patronage and on revenue. The Planning and Design sections on Demand Estimation (Sections 2.2.10 and 3.2.5) describe techniques for relating fares to ridership, while the Operating section (Section 5.2.2D) discusses the experience of operating systems that have raised or lowered their fare structures. The tidbits in the facing exhibit provide some general insights appropriate at the planning level. Using the best information that can be found, the planner should determine for each fare policy alternative:

- Estimated total costs
- Subsidies (by source)
- Revenue; and
- Patronage (by group)

With this information, the council can begin to weigh the consequences of different fare policies.

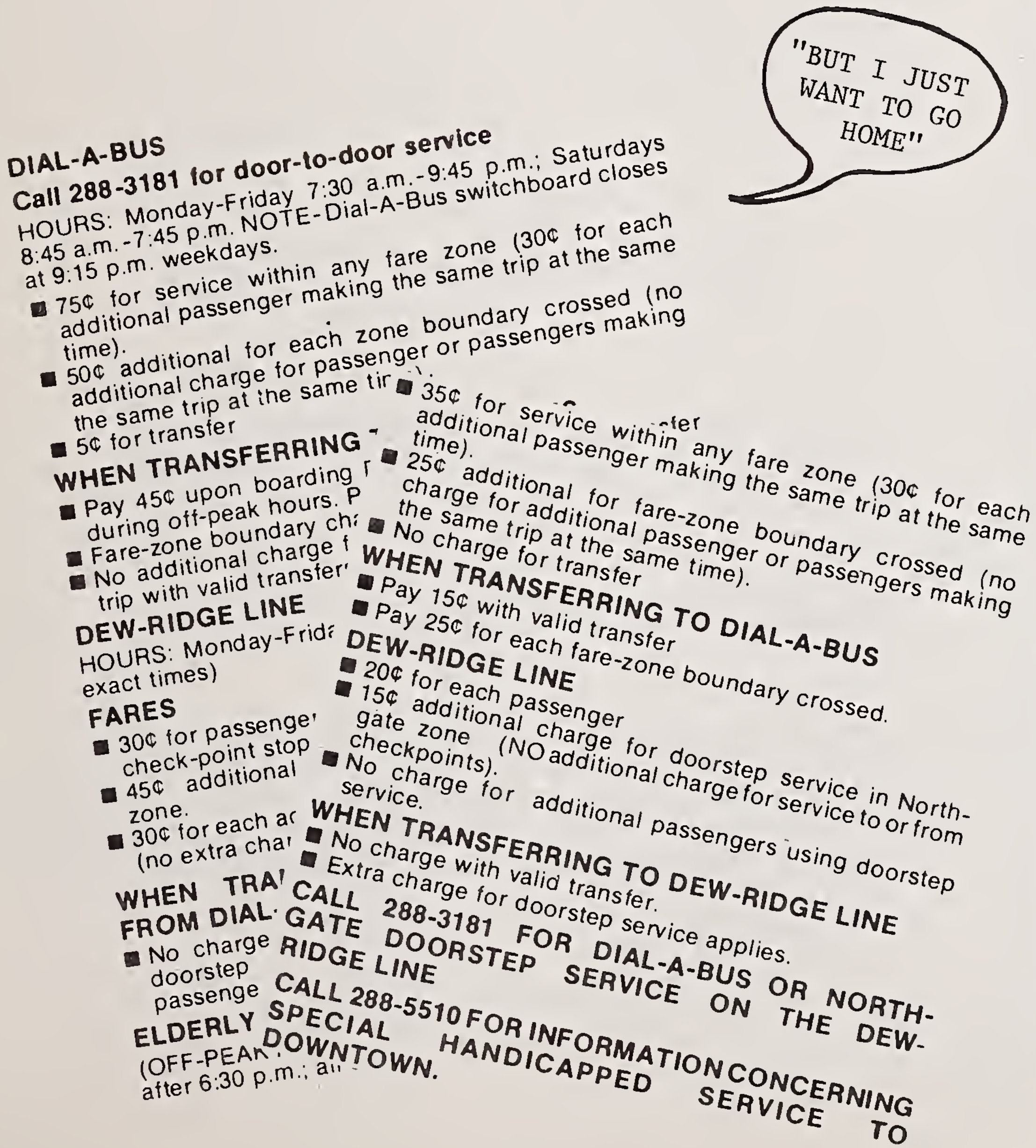
TIDBITS

- Little data exist on fare elasticity in demand-responsive systems. That which does exist (for Haddonfield and a limited number of other sites) suggests that elasticity is relatively low.
- Premium fares for high-quality service can be justified and have been well received by users.
- About half of the systems in operation charge rather low fares. An examination of a variety of existing services showed extremes ranging from free service to costs exceeding one dollar. The most prevalent fare by far was 50¢, which accounted for 57% of all the systems surveyed.
- Although a few shared-ride taxi systems have positive balance sheets, the vast majority of existing paratransit systems fail to break even.
- Political decisions to set arbitrarily low fares can have the effect of swamping the system, resulting in poor service for all users and an ultimate loss of patronage.

P 2.2.10 Rough Demand Estimates
D 3.2.5 Detailed Demand Estimates
O 5.2.2 (D) Changing Fare Structure

KEEP IT SIMPLE

INITIAL VERSION	REVISED VERSION



$1.25 For Service within Service Area
(50¢ for seniors & handicapped) off-peak hours.

5¢ Transfer between Greece & Irondequoit Service Areas.

50¢ For each additional passenger making the same trip at the same time.

WHEN TRANSFERRING TO DIAL-A-BUS FROM ANOTHER SERVICE YOUR DIAL-A-BUS FARE WILL BE THE DIFFERENCE BETWEEN STANDARD DIAL-A-BUS FARE ($1.25 or 50¢) AND YOUR ORIGINAL SERVICE FARE (RTS, SUMMERVILLE SHUTTLE, OR DEW-RIDGE LINE) PLUS 5¢ TRANSFER.

(Source: Rochester, New York PERT service brochure.)

2.2.10 Estimate Demand and Supply

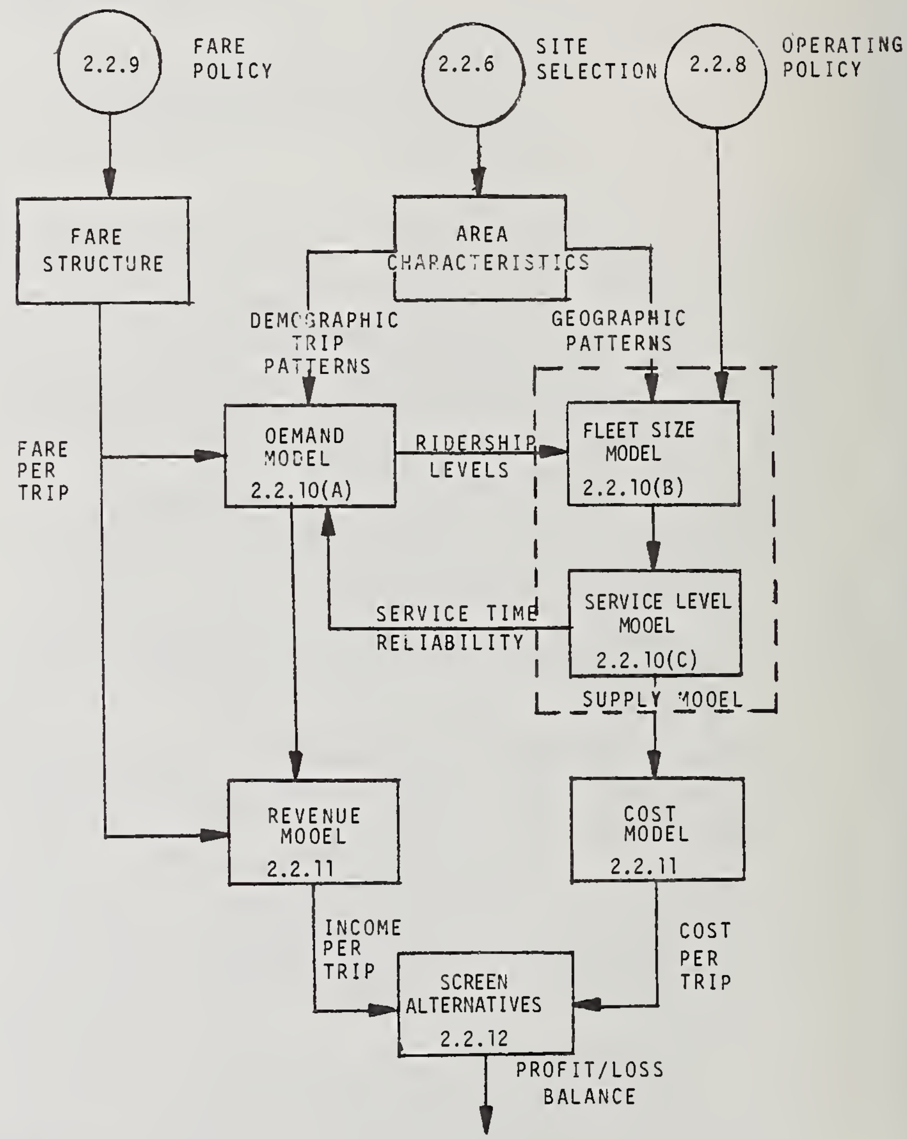
The interactive relationship between supply and demand is typically more complex in paratransit systems than in conventional fixed-route transit systems. In both types of systems, ridership is heavily dependent on the quality of service. In conventional systems, service quality is relatively independent of ridership, except when the capacity of the system is approached. In paratransit systems, however, the quality of service may suffer as ridership increases at any level of demand.

A wide variety of techniques have been proposed to estimate demand, fleet size, service levels, and costs of paratransit systems. Most of these techniques are described and classified in SCRAPS Section 5. To date, however, no single modeling tool has performed with enough consistency to warrant its exclusive use in predicting either demand or supply levels in a paratransit system. Sophisticated, costly approaches have fared no better than simple rules of thumb. Accordingly, in the planning stages, it is advisable to use simple approaches to estimate demand and supply. More detailed estimates can be made if needed in the design stage.

Although the order of presentation in these guidelines treats demand estimation first, followed by supply and cost considerations, the elements are clearly interrelated. The special circumstances of a particular setting may dictate that the planner begin by estimating system supply (if, for example, available financial resources severely limit the supply of vehicles and predetermine the fleet size).

5.0
Use of Models

PLANNING FRAMEWORK FOR ESTIMATING DEMAND, SUPPLY, REVENUES, AND COSTS



(Source: SYSTAN)

(A) Rough Estimates of Demand

Extensive data collection and modeling efforts are generally not worthwhile during the planning stage. In small systems, moreover, such efforts may not be warranted even in the detailed design stage. The flexibility of small paratransit systems, and their ability to respond to demand as it develops, gives the planner a certain amount of leeway in estimating demand levels. Since no single approach to paratransit demand estimation has shown itself to be markedly superior to other approaches, planners are best advised to try a variety of simple estimating techniques. Three such techniques are described below. These three approaches are:

(i) Inference from other paratransit projects;

(ii) Extrapolation from conventional transit ridership; and

(iii) Use of nomographs.

(i) Inference From Other Paratransit Projects. Existing paratransit operations provide a means of estimating the range of likely ridership levels within a specific population area. The following exhibits plot weekday ridership as a function of service area population and demand density as a function of population density for a sampling of 78 general market paratransit operations.

The wide range of performance exhibited by existing systems provides a broad set of limits on likely demand levels when the service area population or population density is used to estimate these levels. The ridership on existing systems ranges from a low of 0.8 rides per day per 1,000 residents to a high of 65.2 rides per day per 1,000 residents, with a median of 9.8.

It is possible to narrow the wide range of possible demand levels somewhat by identifying those sample points that are most similar to the system being planned. (The system descriptions in Appendix 4 can be used to identify systems similar to the system of interest.)

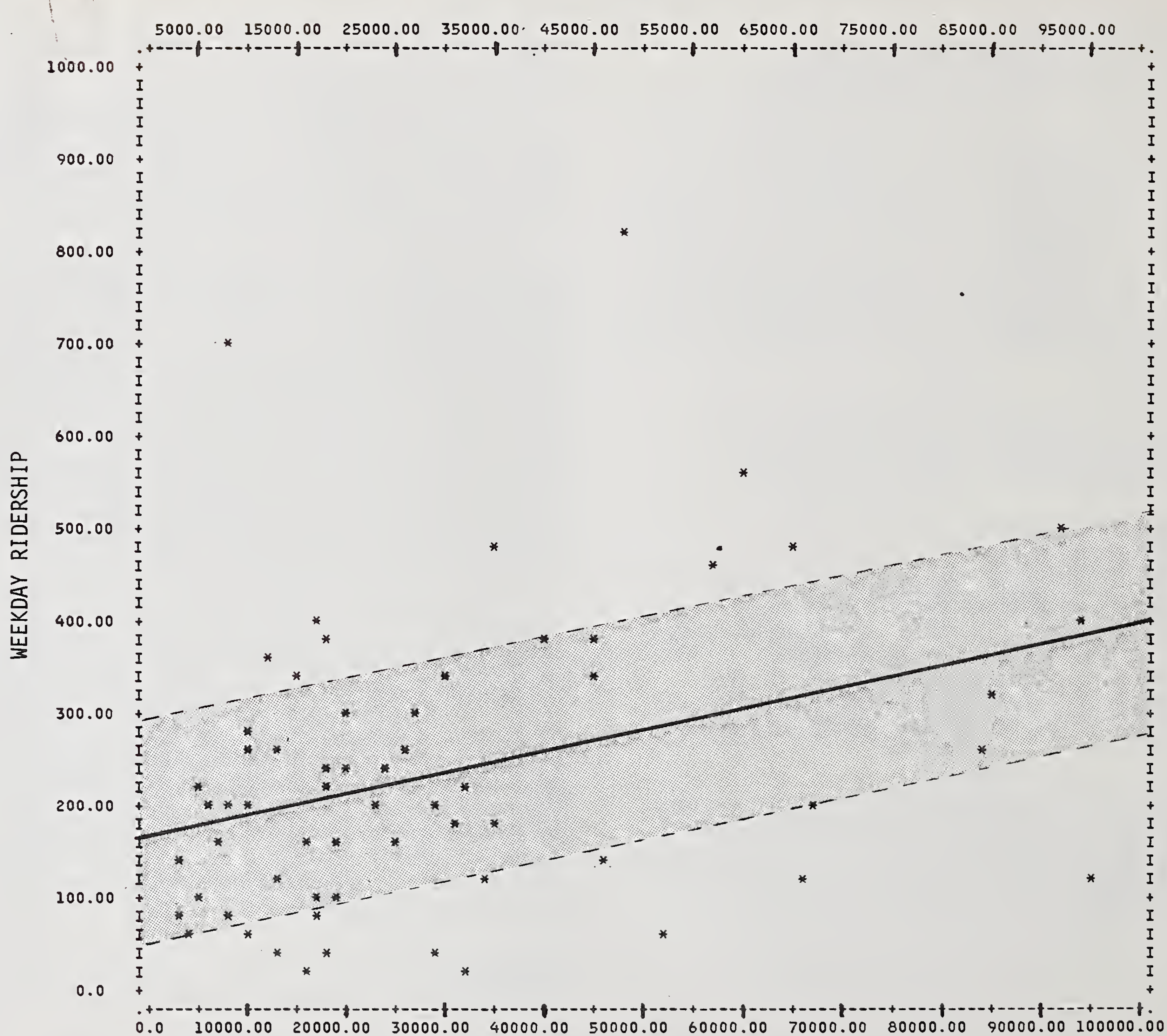
Existing systems are characterized by relatively low ridership densities, between one and four riders per square mile per hour. General planning thresholds are needed indicating the types of systems most appropriate within a range of service areas and population densities. Unfortunately, research has not yet advanced to the stage where such levels can be set with confidence. Taking the wide range of existing experience as a guide, if more than 50 riders per square mile per hour are anticipated, fixed-route service should be considered, while if fewer than two riders per square mile per hour are likely, service should be provided on less than a daily basis (if at all) to encourage the grouping of trips.

(ii) Extrapolation of Site-Specific Conventional Transit Data. Present transit riders comprise the base market for transit services; their needs should be respected and accommodated in planning new services. When an existing system is to be replaced in part or in whole by paratransit service, an estimate of the existing transit ridership should be obtained. This base ridership can be used in estimating the size and distribution of demand for the new service. Although a few systems have reported declines in ridership when paratransit service has replaced a conventional fixed-route bus, it is fairly safe to assume that paratransit ridership will be at least equal to that of conventional public transit. Experience with

Go to A-4 System Descriptions.

2.2.10

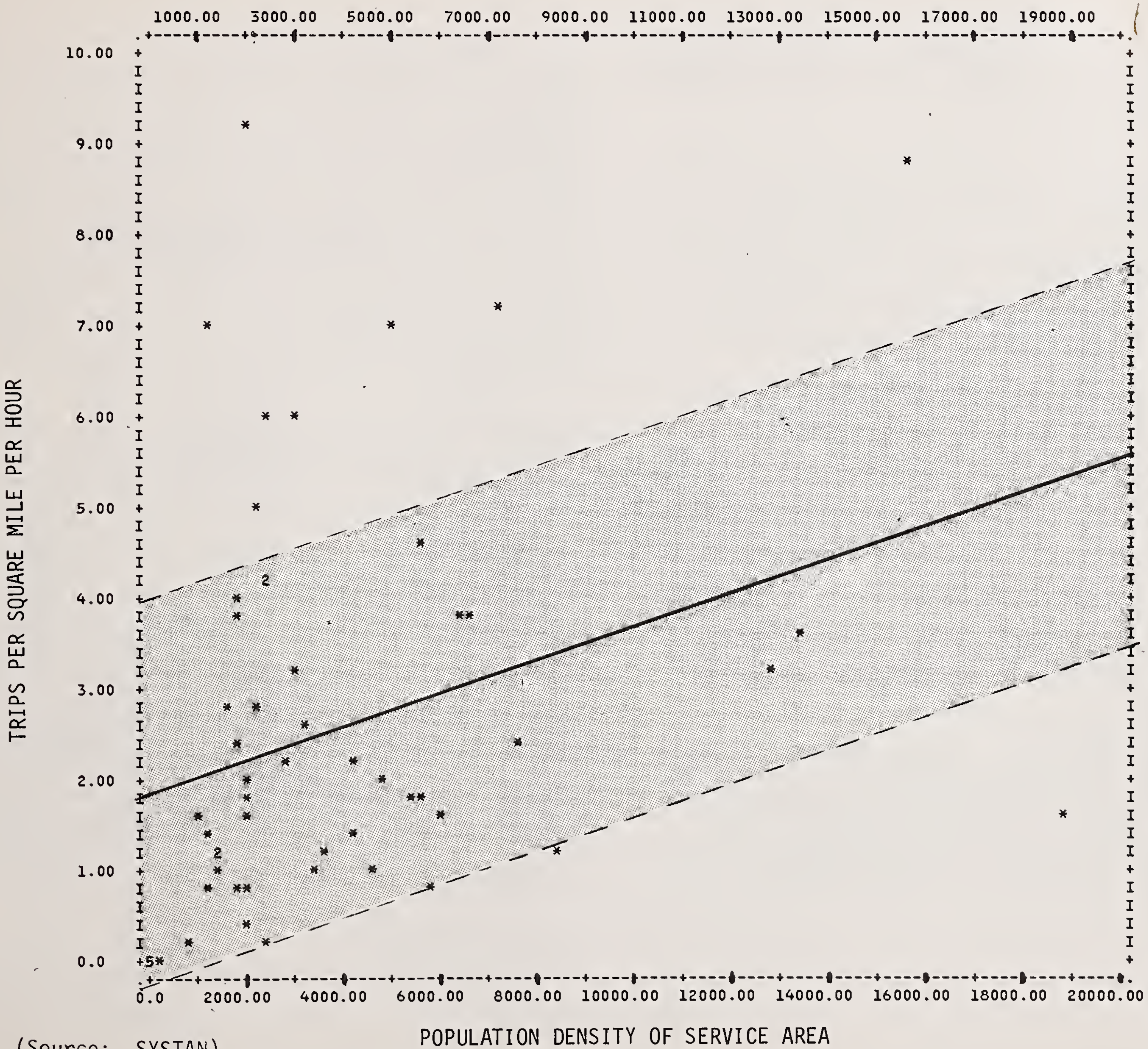
WEEKDAY RIDERSHIP VERSUS SERVICE AREA POPULATION



(Source: SYSTAN)

SERVICE AREA POPULATION

TRIP DENSITY (TRIPS/SQUARE MILE/HOUR) VS. POPULATION DENSITY OF SERVICE AREA



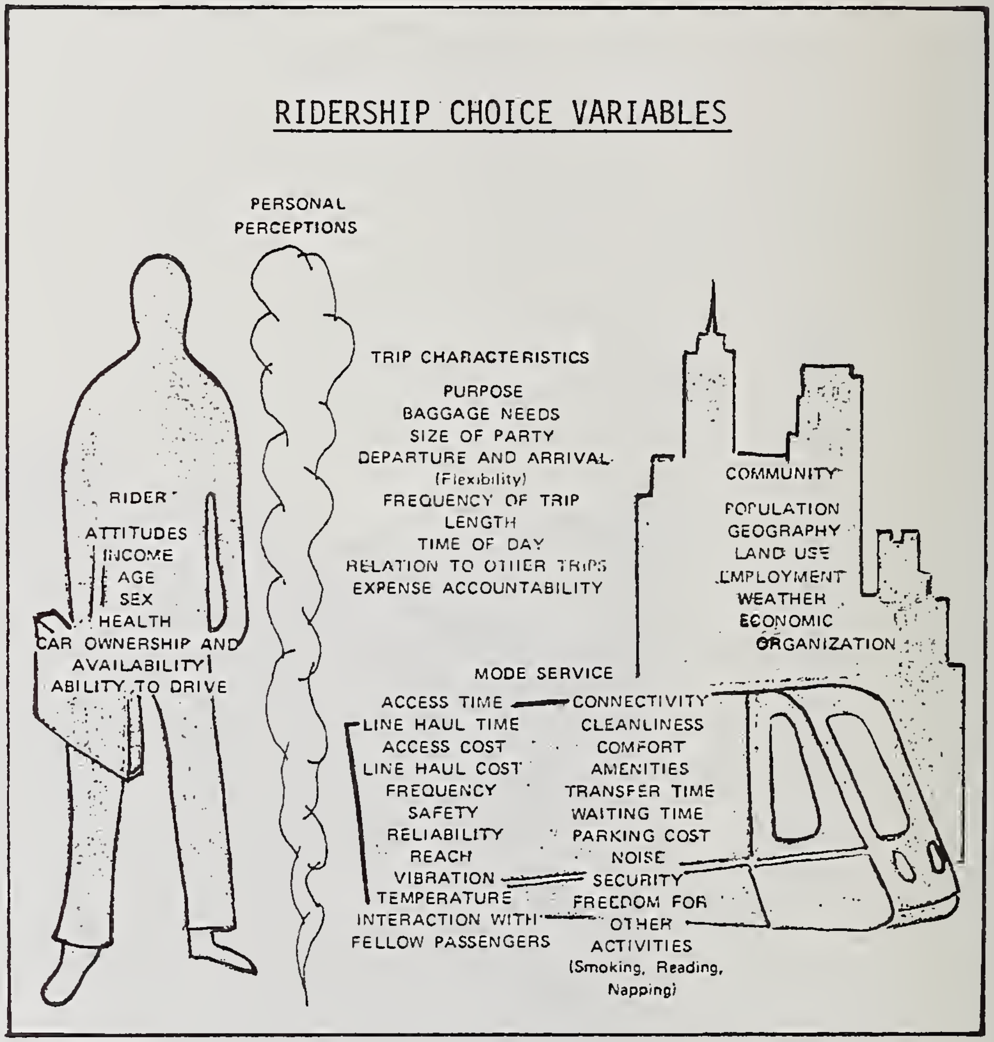
(Source: SYSTAN)

Canadian systems indicates that it is even possible to forecast a slight increase in ridership. There is evidence that transit users will continue to use paratransit instead of the old transit service because of the higher-quality service offered (Reference 4).

The Canadian Dial-A-Bus Manual (Reference 4) cautions, "In evaluating information derived from conventional public transit sources, one must bear in mind that its applicability will be related to the function of existing fixed routes within the service area. If paratransit operates in competition with conventional systems, then the data will have to be used cautiously and the quantities of new and diverted riders calculated separately."

Present taxi riders may also be encouraged to use a new option that gives satisfactory service at a cost substantially below taxi fares. A rough estimate of the level of existing taxi ridership can sometimes be obtained from the local taxi operators, but this information may be limited to the opinions of dispatchers and drivers. Estimates of per-capita taxi ridership in each major U.S. city were made as part of the U.S. Department of Transportation's 1974 National Transportation Study (Reference 27). The amount of taxi ridership diverted to a paratransit system will depend both on the price differential between shared-ride and exclusive-ride service and upon the role of the local taxi operators in providing and supporting paratransit service.

<u>(iii) Use of Nomographs</u>. Transit systems are shaped by the regions they serve, and the characteristics of these regions, as well as the characteristics of the traveler and the need for travel, all help to determine transit system ridership. The facing exhibit lists many of the variables which have a bearing on transit ridership. In



(Source: SYSTAN)

the past, analysts have attempted to develop demand models relating transit ridership to one or more of these characteristics of the rider, the community, the transit system, and the trip itself. In the paratransit planning process, it is desirable to focus on a few key variables requiring a minimum amount of data collection effort. One approach to demand estimation that focuses attention on a limited number of variables entails the use of nomographs. The accompanying exhibit contains a nomograph relating paratransit ridership to service area population, car ownership characteristics, and projected fare. This nomograph was initially developed for use in the San Diego region (Reference 60), but tests have shown that it performs as creditably as more complex estimating procedures in a variety of settings.

The system patronage estimate resulting from the use of the accompanying nomograph covers an average weekday during a 12-hour service period. The information required to use the nomograph is:

(1) The number of households in the service area;

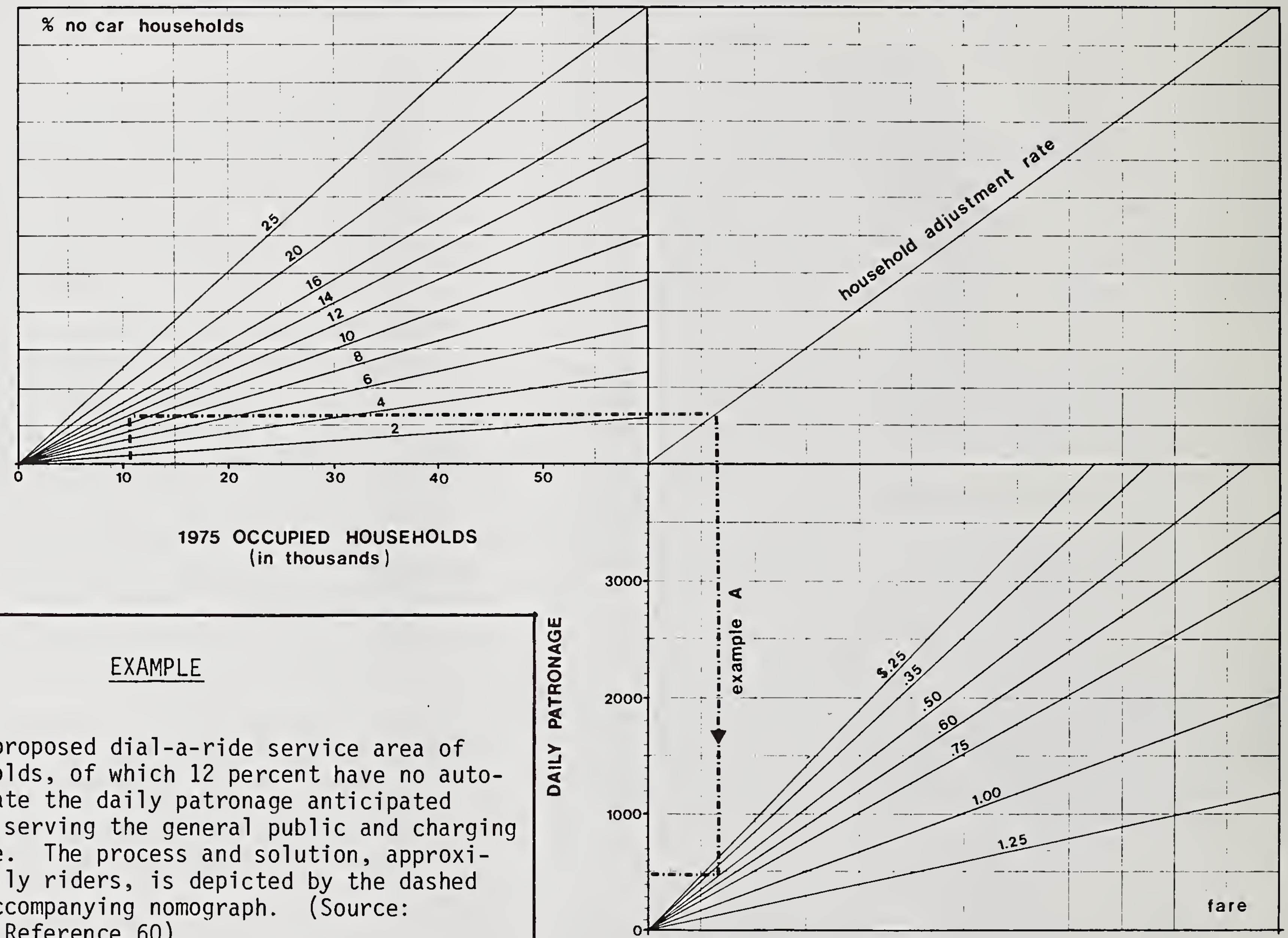
(2) The percentage of autoless households in the service area; and

(3) An initial fare level.

Items (1) and (2) are readily available from census data. A tentative initial fare level (Item 3) may have been established in the earlier consideration of fare policy (Section 2.2.9). If several tentative levels are of interest, the nomograph may be used to gauge the impact of fares on patronage levels.

2.2.9
Fare Policy

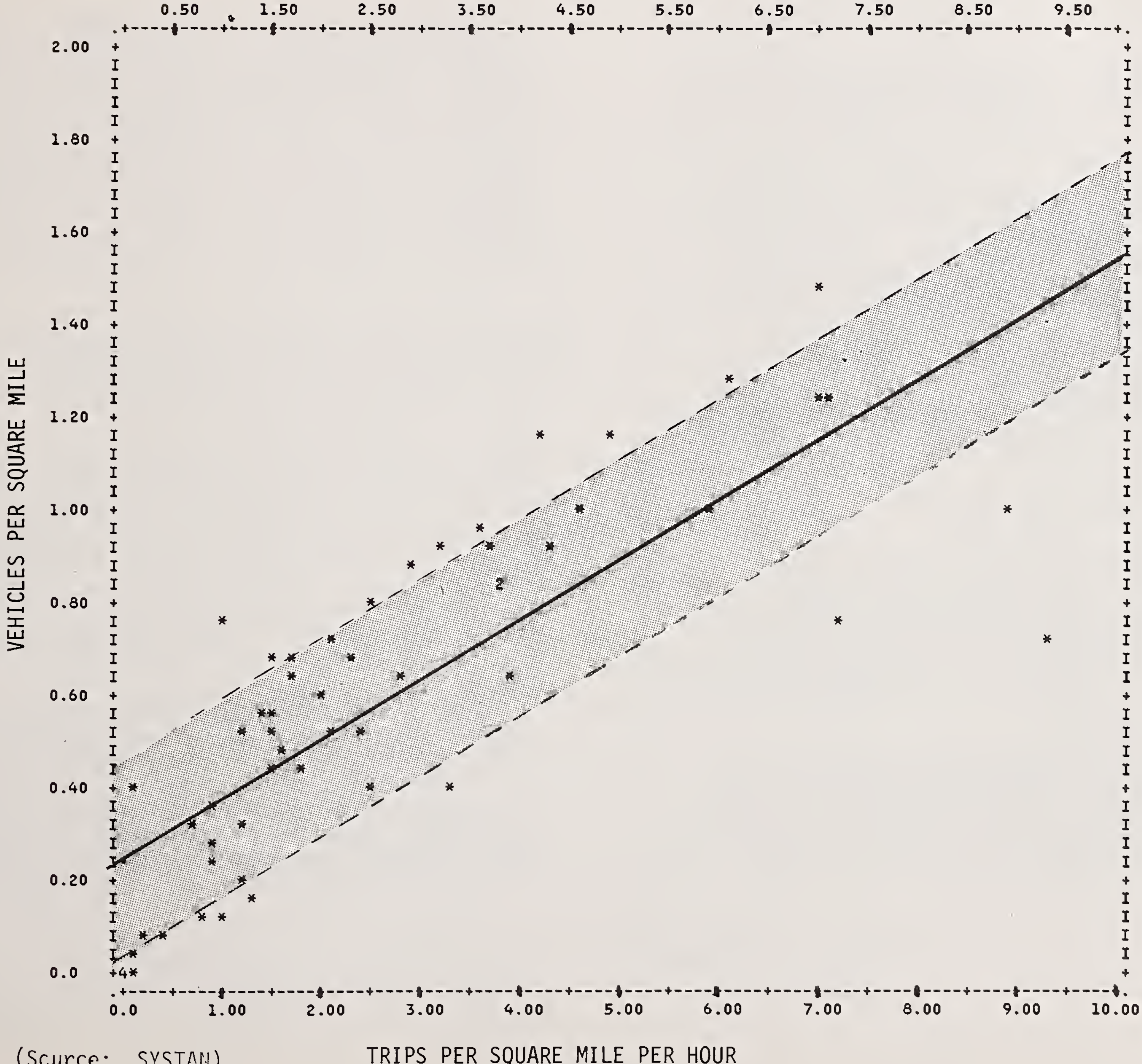
PATRONAGE NOMOGRAPH (GENERAL PUBLIC)



EXAMPLE

Given a proposed dial-a-ride service area of 10,700 households, of which 12 percent have no automobile, estimate the daily patronage anticipated from a system serving the general public and charging a 50-cent fare. The process and solution, approximately 500 daily riders, is depicted by the dashed line in the accompanying nomograph. (Source: Wilbur Smith, Reference 60)

VEHICLES PER SQUARE MILE VS. TRIP DENSITY (TRIPS/SQ.MI./HR.)



(Source: SYSTAN)

P 2.2.10

Instructions for the use of the nomograph are as follows:

> "...the number of households within the service area is first located on a horizontal axis and a vertical line established to intersect with the line representing the percentage of service area households having no automobile. A horizontal line is traced from that point to intersect the 'Household Adjustment Rate.' A vertical line is traced from the point of intersection on the 'Household Adjustment Rate' to the selected fare level and a horizontal line is then traced to the patronage axis. The estimated weekday patronage is indicated by the intersection point. Throughout the procedure, intermediate points not falling directly on a line may be approximated between the appropriate lines." (San Diego Guidelines, Reference 60)

(B) Rough Estimates of Fleet Size

The number of paratransit vehicles required to maintain acceptable service levels within a proposed service area will depend primarily upon travel demand patterns, service area size, and the type of service provided. This section explores the relationship between these factors, first, by examining existing systems, and second, by extending the nomograph approach introduced in developing demand estimates.

<u>(i) Inference From Other Paratransit Projects</u>. The preceding exhibit plots fleet size as a function of demand density for 57 U.S. operations. As can be seen, the relationship between fleet size and demand is somewhat better defined than the relationship between demand and population, though a variety of fleet sizes exists at every demand level. To some extent, this variety reflects the inherent flexibility of the paratransit concept...a given number of vehicles may handle varying ranges of demand. However, the range depicted in the the graph also reflects differences in operating policies, fare levels, and system configurations among the 57 systems sampled. As with demand, for the purposes of estimating a range, one should consider systems with an operating policy, fare structure, and system configuration similar to the planned system.

Guidelines developed for planners in Southern California offer the following rule of thumb for estimating the number of paratransit vehicles needed to provide general market service: Allow one seat for each 1,040 people in the service area (Reference 199). Although this rule may be adequate for rough planning purposes, its practical applicability is indicated by the following admonition, which the developers of the rule offer along with the rule itself: Estimate the required number of buses using the derived rule of thumb relationship. Then divide that number by two and proceed cautiously.

Whatever the technique used to estimate fleet size in the planning stage, more detailed analysis will be undertaken during the design phase (Section 3.2.5).

<u>(ii) Use of Nomographs</u>. The number of paratransit vehicles needed to maintain acceptable service levels within a proposed service area is primarily dependent upon travel demand patterns, service area size, and service type. The accompanying nomograph relates vehicle fleet size to these parameters. As with the demand nomograph presented earlier, this fleet size nomograph was developed for use in the San Diego area

D 3.2.5
Detailed Fleet
Size Estimation

(Reference 60). However, the relationships are sufficiently general to be used for preliminary planning of general market systems. Because target market systems serving the elderly and handicapped tend to have longer dwell times and serve larger areas than general market systems, separate estimates of vehicle requirements should usually be made for target market systems. In the event that a target market system is designed to serve a relatively small area (i.e., under 20 sq.mi.), the subsequent nomograph can also be used for target market systems. (Section 4.2.7 discusses target market demand estimation)

The initial input needed in applying the accompanying nomograph is patronage per square mile, which is calculated by dividing the patronage estimate developed earlier by the number of square miles within the service area. Using this number,

> "A vertical line should be traced from the patronage per square mile to the 'Off-Peak Vehicle Factor' curve. A horizontal line should be traced from the intercept point on this curve to the diagonal line representing the appropriate service area size. The intermediate intercept with the vertical axis represents the average vehicles per square mile during the off-peak service period."

> "Final adjustment factor is the peak period service type and ridership market, represented by the five diagonal lines, A through E. Fleet size is determined by tracing a vertical line from the area size intercept to the line representing the service type proposed during peak travel demand conditions. A horizontal line is traced from the service type to intersect the fleet size axis. If the intercept is between numbers, the next higher number should be used as the fleet size requirement for the area. Alternative service types may be tested to determine the effect of each upon vehicle requirements." (Reference 60)

4.2.7
Target Market
Demand Estimation

(C) Rough Estimates of Service Levels

The simple approaches proposed for estimating demand and fleet size provide rough planning guidance, but give little insight into such service concerns as wait time, ride time, and system reliability. For planning purposes, the simplest approach to estimating these service parameters is to review the reported performance of systems similar to those which are being considered. The System Characteristics section summarizes performance parameters for several classes of systems, while individual system performance is documented in the system survey sheets of Appendix 4.

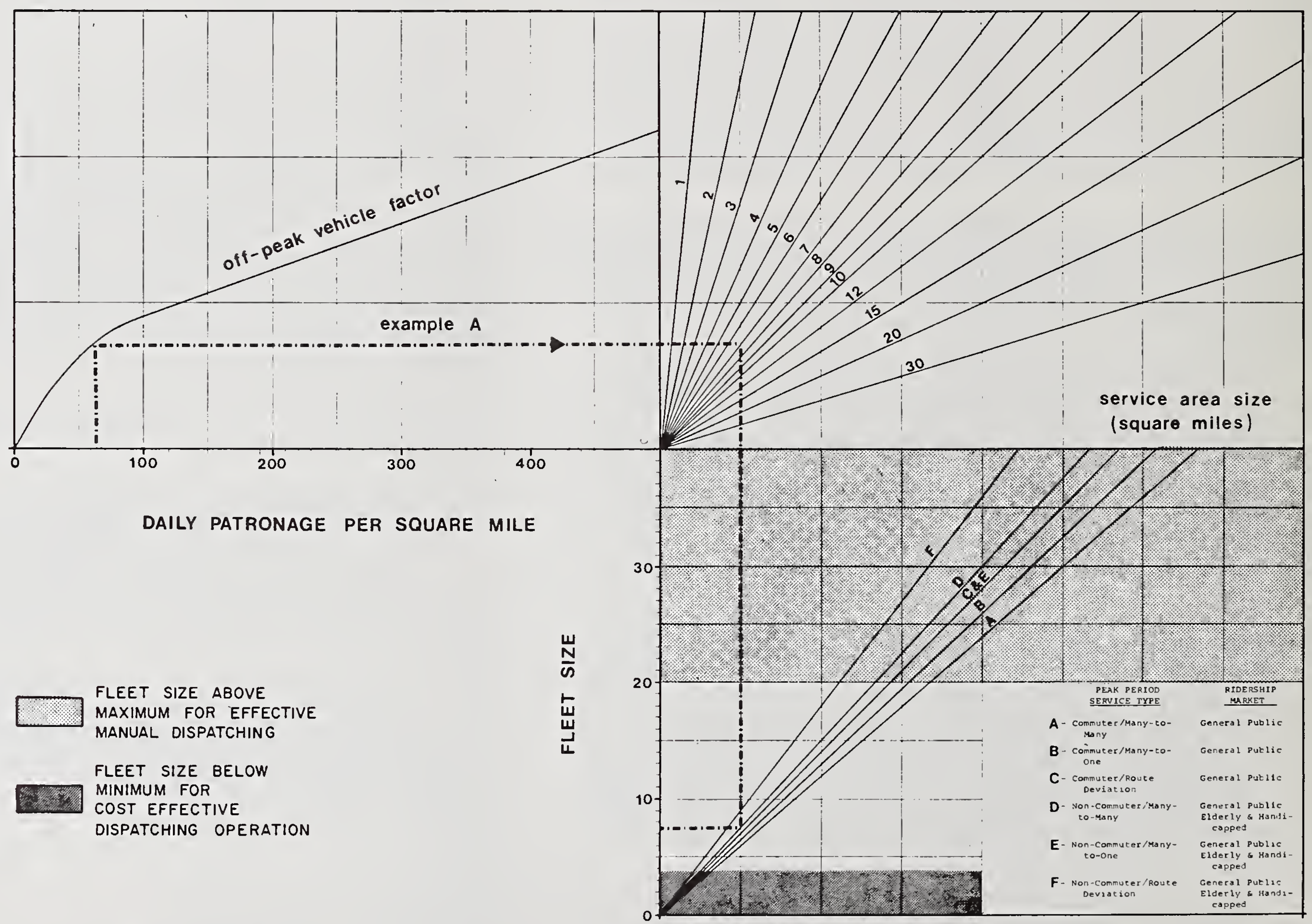
A few general observations regarding the performance of existing paratransit systems are listed below:

- The median ride time reported by a sample of 34 general market systems was 13 minutes for trips having a median distance of 2.2 miles. Target market trips are longer, having a median length of 4.4 miles and a median travel time of 20.0 minutes.

- The median wait times for general market service was 15.0 minutes, and ranged from 2 to 37 minutes. Target market systems reported wait times ranging from 5 to 45 minutes, with a median of 20 minutes.

Go to
A-4
Individual
System
Sheets

FLEET SIZE NOMOGRAPH



(Source: Wilbur Smith, Reference 60)

- An important service index, reliability, has not been adequately measured in most dial-a-bus systems. Limited data suggest that, on the average, the actual wait time is shorter than the promised wait time. That is, buses typically arrive early, and about 60% of the systems have an average arrival time within 10 minutes of the promised arrival time.

- In Rochester, planners found it advisable to specify a range of arrival times ("The bus will arrive in 15 to 20 minutes") rather than to promise a specific arrival time ("The bus will be at your door in 20 minutes").

- Both waiting times and travel times on existing paratransit systems are longer than those experienced by automobile users. For the short trips typical of existing systems, the ratio of total trip time by dial-a-bus to the time by auto may be three to one or greater. It is only on longer express trips to a distant CBD that an integrated paratransit system comes close to equaling auto travel time.

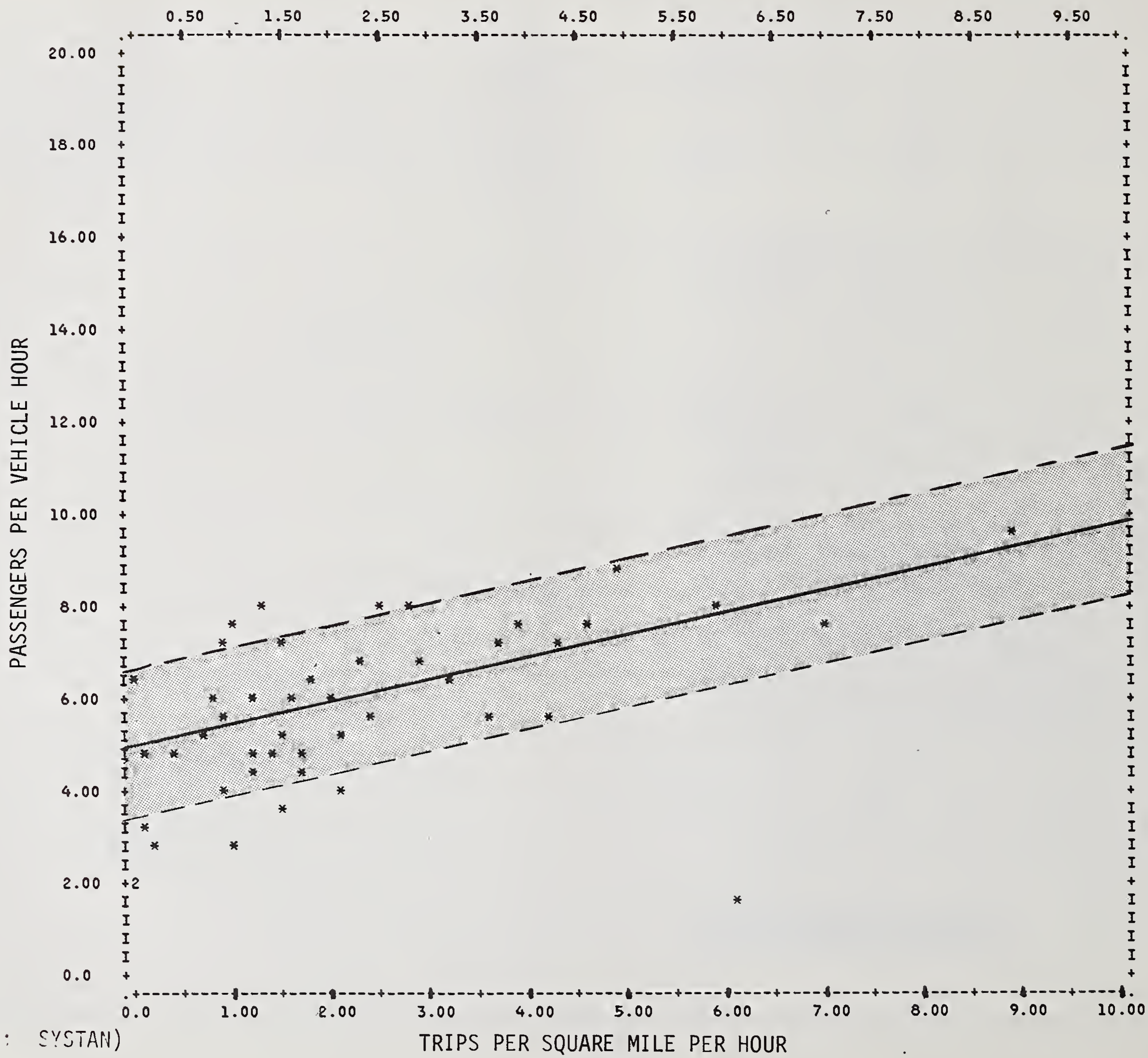
(D) Rough Productivity Estimates

Productivity can be roughly estimated by studying existing system performance. Calculated in terms of passengers per vehicle-hour, median vehicle productivity was 5.76 for 60 general market systems. Productivity was generally lower for target market systems, with a median of 3.0 passengers per vehicle-hour. There were generally between .4 and .6 passengers per vehicle-mile on the general market and SRT target market systems, with somewhat lower figures for the DAB target market systems.

Although productivities as high as 15 trips per vehicle-hour have been recorded in Regina, where demand densities approach 25 trips per square mile per hour, demand densities in most U.S. cities range from below one passenger-trip per square mile per hour to about five passenger-trips per square mile per hour. At these densities, productivities range from two to ten trips per vehicle-hour.

2.2.10

PASSENGERS PER VEHICLE-HOUR VS. TRIP DENSITY (TRIPS/SQ.MI./HOUR)



(Source: SYSTAN)

2.2.11 Estimate Costs and Revenues

At this stage, the planner can derive an estimate of costs and revenues from the limited knowledge at his disposal: (1) approximate number of vehicles needed; (2) an estimate of the vehicle-miles per hour (a number which can be extended to vehicle-miles per day or per year); (3) rough estimates of patronage; and (4) one or more fare policies.

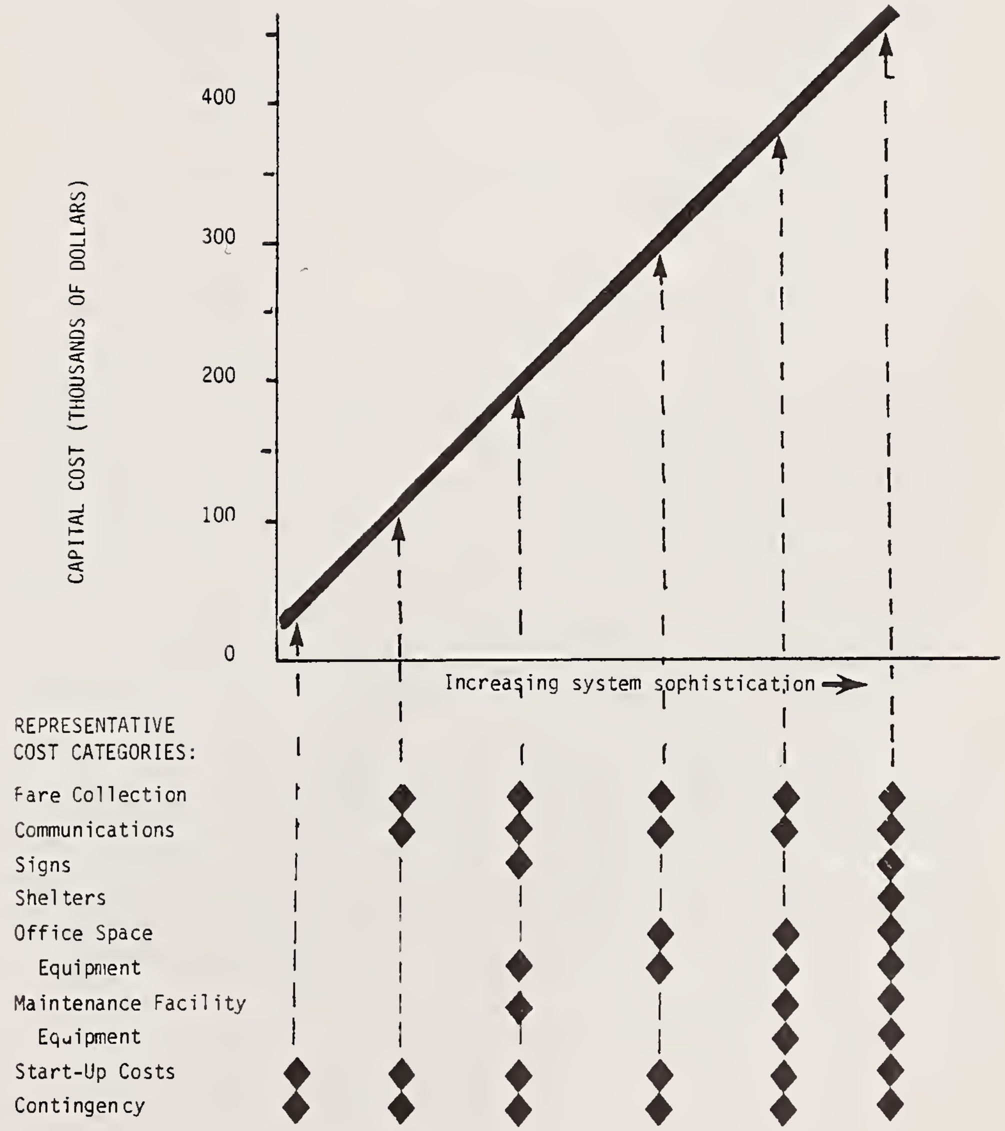
(A) Cost Estimate

Separate estimates need to be made for capital and operating costs.

(i) Capital Costs. Capital assets for demand-responsive services consist of vehicles, shelters, signs, communication equipment, fare collection equipment, office space, maintenance facilities, office furnishings, maintenance equipment and start-up costs. Allowance should also be made for contingencies. Actual requirements vary widely because of opportunities for sharing some assets with other services. The exhibit illustrates estimated non-vehicular capital assets as a function of the types of support equipment that is provided. As a bare minimum, a new service needs \$20,000 to \$30,000 to cover start-up costs and a contingency against delays, unexpected difficulties and low initial revenues. At the other extreme, as much as \$500,000 can be invested in a full set of support equipment

At the planning stage, capital cost estimates should be based on vehicle needs with an allowance for other assets.

NON-VEHICULAR CAPITAL COSTS



(Source: SYSTAN)

2.2.11

The prices for some of the more common demand-responsive vehicles are listed below. New-vehicle prices tend to be close to the top of each range. Used-vehicle prices can fall anywhere in between. A crude capital cost estimate can be made by extending the estimated number of vehicles by a figure near the top of the price range.

Automobiles (SRT)	$ 5,000
Standard Vans	5,000-9,500
Converted Vans	9,000-14,000
Minibuses	23,000-42,000
Converted Motor Homes	14,000-65,000

Other assets' capital costs can be estimated from the previous exhibit, which suggests approximate costs different levels of outfitting. For example, capital costs for a demand-responsive transit system that includes fare collection equipment, communications equipment, signs, and office equipment would amount to about $200,000 when start-up costs and a contingency are included. Actual costs will vary around that figure, depending on system size, local cost levels, and the availability of equipment and services at no cost from other agencies.

<u>(ii) Operating Costs</u>. The operating costs of a proposed system can be estimated quickly using factors and unit costs that have been carefully drawn from the cost experience of existing operators. These estimates should then be modified to reflect the extent of the services to be offered. Data from the System Summary Sheets (in Appendix 4) reveal a range in cost per vehicle-hour of between $5.00 and $22.00 (see Part 3, Section 3.1.5 for distributions). Although the means of the two distributions were close ($10.00 versus $9.95), the DAB costs were more variable than the taxi costs. The DAB variations were due to the many differences in the services furnished and the cost of DAB labor.

To estimate operating costs, the planners must have a basis for selecting a particular hourly or mileage charge rate. This basis can be found by exploring the principal sources of variation: labor cost and service scope. The exhibit shows the distribution of wage rates for 33 DAB and 11 SRT services. The DAB rate distribution is dominated by systems in small cities in Michigan and California. The highest rates occurred in large cities where demand-responsive service is performed in conjunction with conventional transit service. City size and geographic location influence labor rates. As indicated in the following tabulation, large cities have higher transit rates than small cities:

<u>WAGE RATES BY POPULATION GROUP</u>
(from selected cities, July 1, 1975)

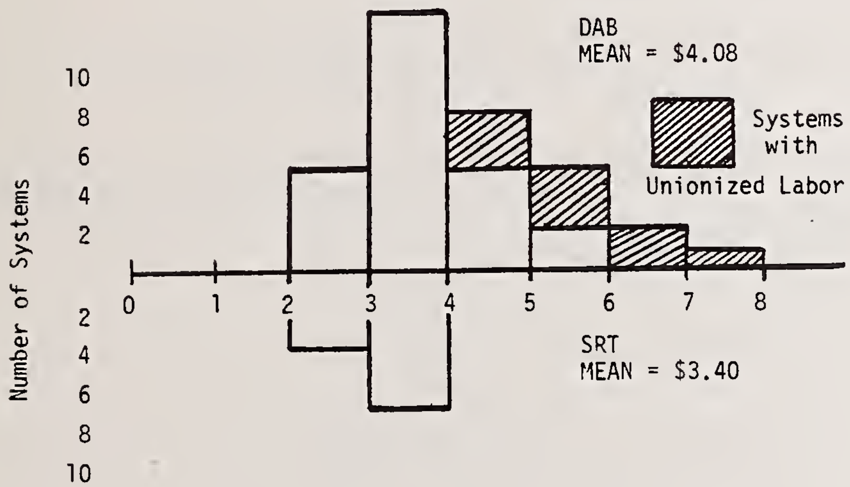
Population Group	Average Hourly Rate
1,000,000 or more	$6.24
500,000 - 1,000,000	5.94
250,000 - 500,000	5.54
100,000 - 250,000	4.81

(Source: Paratransit Labor Issues, Reference 104)

3.1.5
Distribution of Cost
Per Vehicle-Hour

WAGE RATES

(Including Integrated Systems)



(Source: SYSTAN)

However, taxi rates tend to be more uniform. Those paratransit services that use taxi-based labor generally benefit from lower labor costs. Geographic wage differences tend to follow general labor trends. These rates tend to be dominated by rates in large cities.

Wage Rates and Increases in Wage Rates for Local Transit Operating Employees, by Region (7/1/74-7/1/75)

Region	Average Hour Rate (7/1/75)	Change from 7/1/74 Cents/Hour	Percent
New England	$6.23	66	11.8
Middle Atlantic	6.44	57	9.8
Border States	6.42	81	14.3
Southeast	5.32	53	11.1
Southwest	4.42	47	11.9
Great Lakes	6.39	59	10.1
Middle West	5.83	42	7.9
Mountain States	5.28	55	14.5
Pacific States	6.50	83	14.5
All Regions	6.25	64	11.3

(Source: Paratransit Labor Issues, Reference 104)

Union affiliation seems to increase dial-a-ride wage rates, but it does not appear to have the same influence on shared-ride taxi wages. Of the dial-a-ride systems responding to the SYSTAN survey, nine reported using organized labor (San Diego, California; Columbus, Ohio; Haddonfield, New Jersey; Ann Arbor and Grand Rapids, Michigan; Rochester and Syracuse, New York; and Austin and Houston, Texas). Wage rates in these nine cities were the highest reported (see exhibit). Some cities (e.g., Cleveland) have successfully negotiated arrangements whereby paratransit labor rates are lower than conventional transit rates.

P 2.2.11

Direct operating costs can be estimated with reasonable accuracy if one knows the expected labor wage rate and the number of vehicle-hours or vehicle-miles of service to be provided. Even this is a clouded issue because some systems use part-time, volunteer or CETA labor while others pay full scale and observe the provisions of Section 13(c). Supporting costs vary widely from system to system. The exhibit to the right lists the composition of operating costs for eight demand-responsive systems. The vehicle-hour costs of these systems vary from $7.38 to $20.11; their costs per vehicle-mile vary between $0.64 and $1.31. In each case, labor cost is the largest single expense item, accounting for about sixty percent of all costs. Aside from these factors, few consistencies can be found in the operating costs listed in the exhibit. Management and administrative costs depend on the size of the system and the extent of outside management involvement.

Maintenance costs depend heavily on the type and extent of services (see Section 3.2.8(C)). Insurance costs are relatively consistent, but some systems are self-insured and some are insured by others. Only four of the eight systems responding to the survey listed asset depreciation as a cost, and only four listed marketing costs.

Until an organizational structure has been specified, the planner can make a rough estimate of likely operating costs. If the planner knows the labor rate (wages plus benefits), and if he can estimate whether the proposed service can manage with only minimal support (office space, administrative services, insurance provided by others at no cost), normal support or maximal support (free standing organization with demonstration status), the likely cost per vehicle-hour can be estimated from the graph. For example, with a labor rate of $5.00 per hour and normal support, estimated operating costs would be $14.10 per vehicle-hour. Small system costs tend toward the maximal support line, and large system costs will be closer to the minimal support line if economies of scale are doggedly pursued.

If the labor rate is unknown, it must also be estimated. Data on city size, region of the country, and taxi or transit base can be helpful. If all else fails, mean rates drawn from operating experience can be used.

(B) Revenue Estimate

Experience with revenues indicates the service that is selling; it tells little about what might sell.

Per-passenger revenue is always lower than fare due to special fares for elderly, handicapped, and other target groups. Median revenue per passenger for several different services are listed below:

- General Market

DAB	0.29
SRT	0.45
Integrated	0.55

- Target Market

DAB	0.37
SRT	0.50

D 3.2.8(C)
Vehicle Maintenance

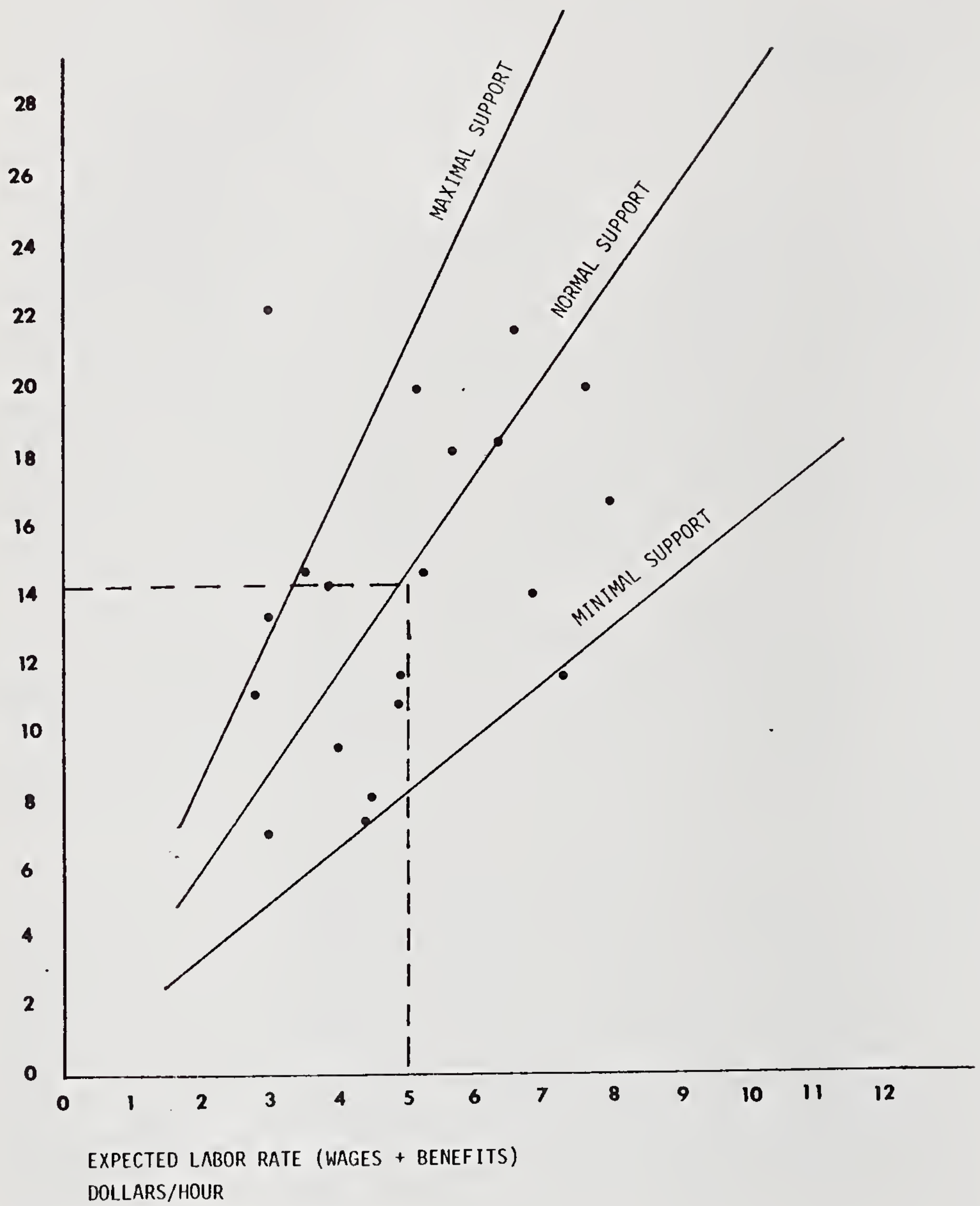
OPERATING COST EXPERIENCE

<table>
<tr><th>CATEGORY</th><th>CITY A</th><th>CITY B</th><th>CITY C</th><th>CITY D</th><th>CITY E</th><th>CITY F</th><th>CITY G</th><th>CITY H</th></tr>
<tr><td>DATE</td><td>1976</td><td>1975</td><td>1975</td><td>1976</td><td>1978</td><td>1977</td><td>1978</td><td>1977</td></tr>
<tr><td>MANAGEMENT ADMINISTRATION</td><td rowspan="3">70.6%</td><td rowspan="3">57.7%</td><td rowspan="3">64.3%</td><td rowspan="3">67.8%</td><td>9.2%</td><td>11.0%</td><td>10.0%</td><td>6.6%</td></tr>
<tr><td>LABOR</td><td>46.7</td><td rowspan="2">64.0</td><td>59.4</td><td>73.9</td></tr>
<tr><td>BENEFITS</td><td>8.3</td><td>17.6</td><td>12.9</td></tr>
<tr><td>MAINTENANCE</td><td rowspan="2">10.9</td><td>14.7</td><td>11.1</td><td>10.9</td><td>6.7</td><td rowspan="2">14.0</td><td rowspan="2">11.0</td><td></td></tr>
<tr><td>FUEL</td><td>9.1</td><td>5.6</td><td>4.4</td><td>14.2</td><td></td></tr>
<tr><td>MARKETING</td><td></td><td></td><td></td><td></td><td>1.7</td><td>4.0</td><td>1.0</td><td>0.3</td></tr>
<tr><td>INSURANCE</td><td>5.5</td><td>4.9</td><td>3.1</td><td></td><td>5.0</td><td>4.0</td><td>1.0</td><td>5.5</td></tr>
<tr><td>UTILITIES</td><td>1.0</td><td></td><td></td><td></td><td></td><td>1.0</td><td></td><td></td></tr>
<tr><td>FACILITIES</td><td></td><td></td><td></td><td>2.5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>DEPRECIATION</td><td>12.0</td><td>11.2</td><td>14.4</td><td>12.5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>TELEPHONE</td><td></td><td>1.8</td><td>1.3</td><td></td><td>1.3</td><td>1.0</td><td></td><td></td></tr>
<tr><td>MISCELLANEOUS</td><td></td><td>0.6</td><td>0.2</td><td>4.4</td><td>4.4</td><td>1.0</td><td></td><td>0.8</td></tr>
<tr><td>ANNUAL COST (THOUSANDS)</td><td>163</td><td>106</td><td>94</td><td>171</td><td>144</td><td>120</td><td>106</td><td>366</td></tr>
<tr><td>VEHICLE-MILES (THOUSANDS)</td><td>180</td><td>133</td><td>104</td><td>91</td><td></td><td>187</td><td>81</td><td>324</td></tr>
<tr><td>COST/VEHICLE-MILE</td><td>0.91</td><td>0.80</td><td>0.90</td><td>1.87</td><td></td><td>0.64</td><td>1.31</td><td>1.13</td></tr>
<tr><td>VEHICLE-HOURS OPERATED</td><td>11.938</td><td>9,120</td><td>8,328</td><td>8,484</td><td></td><td>16,260</td><td>8,254</td><td>21,351</td></tr>
<tr><td>COST/VEHICLE-HOUR</td><td>13.65</td><td>11.62</td><td>11.23</td><td>20.11</td><td></td><td>7.38</td><td>12.84</td><td>17.12</td></tr>
</table>

(Source: Compiled by SYSTAN)

2.2.11

OPERATING COST ESTIMATOR



(Source: SYSTAN)

The planner should rely heavily on the revenue experience of other systems similar to the one being planned (given comparable fares). If higher revenues are expected than present services are receiving, the reason for the higher expectation should be documented. If higher fares are to be charged, some estimate of the sensitivity of ridership to fare needs to be recognized when revenues are estimated.

COSTS ARE ALMOST ALWAYS UNDERESTIMATED!

2.2. 12 Screen Alternatives

Planning should be creative, dynamic and responsive in the quest for the best possible service to fill a transportation need. Citizen participation in the planning process will generate many ideas which need to be screened, along with other alternatives, to provide the best service option.

The screening process needs to be careful; it needs to be methodical; and it should protect the interests of all affected parties. Of the number of screening processes, the best known is the scoring model, which is described in this subsection. The design and execution of a scoring model requires the following activities:

- o Select screening criteria;
- o Design scoring model;
- o Execute scoring model; and
- o Interact with citizen groups.

These activities should be performed in a spirit of openness and objectivity. The presumption behind the process is that all alternatives under study are serious candidates; any one could be selected. No "straw men" are wanted! Sample applications of the proposed screening process may be found in References 4 and 47.

(A) Select Screening Criteria

Screening criteria should reflect the interests of all the program participants: users, non-users, transit operators, local government agencies, community members and perhaps state and federal government agencies.

SAMPLE EVALUATION CRITERIA

Criterion	Interested Participants
Site	Users, community
Accessibility	Users
Availability	Users
Mean travel time	Users
Service hours	Users, operator, community
Fare	Users, local government
Patronage	Operator, local government
Change in automobile availability	Mobility-deficient
Profit potential	Operator, local government
Vehicles	Operator, community
Capital investment	Operator, local government
Annual operating cost	Operator, local government
Owner type	Owner, local government
Impact on existing transit	Transit operator, local government
Impact on existing taxi	Taxi operators
Financial risk	Operator, local government
Service to social service agencies	Social service agencies, target groups
Impact on business community	Businesses, local government, community
Congestion	Community, local government
Pollution	Community, industry
Energy use	Community

(Source: Lewis and Jones, Reference 47)

2.2.12

There is no magic number or set of screening criteria. Each situation warrants the development of its own specific set of screening criteria. At this stage, the list of screening criteria should be short and should reflect planning-type information. Highly-specific criteria have little use if measures are not available until after the design is complete. The exhibit on the next page organizes 23 criteria into six categories. Each category should be represented in the screening process by one or more criteria. It is important to balance the criteria among the different categories. It is also useful to restrict the list to ten or fewer screening criteria.

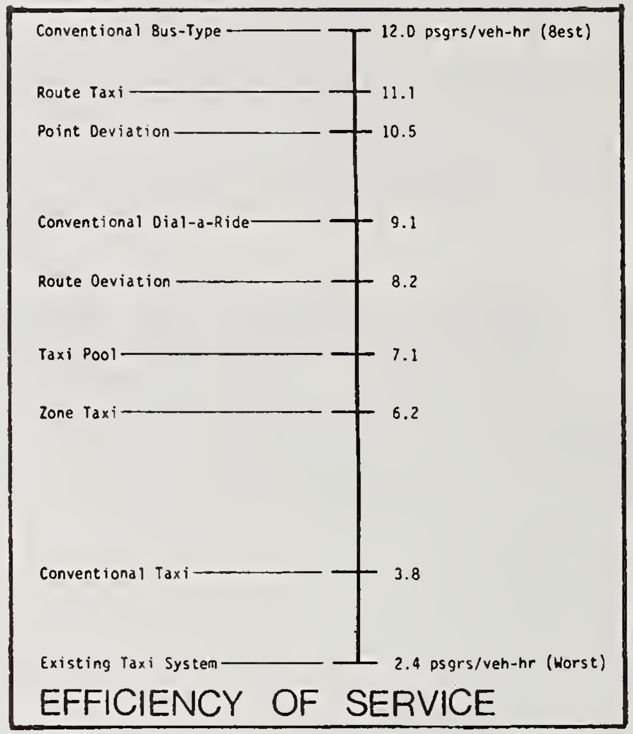
(B) Design Scoring Model

Once the set of screening criteria has been selected, there are two important steps in the design of the scoring model: quantifying criterion values, and selecting criterion weights.

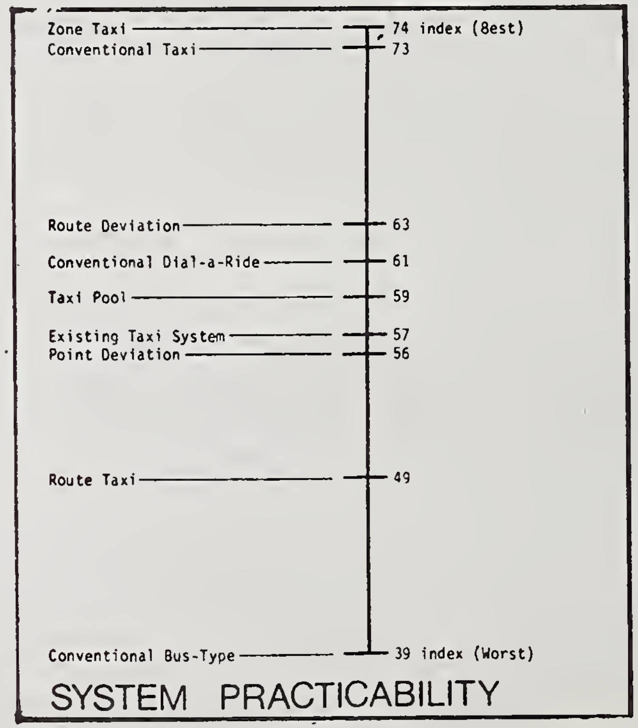
(i) Quantify Criterion Values. There are two possible approaches to quantifying criterion values: (1) a numerical rating scheme can be applied to each criterion by a group of raters, or (2) absolute or relative values can be sought for each criterion reflecting the value of each alternative.

The rating scheme requires that a panel of raters be assembled that reflects all participants. Each rater is asked to evaluate each project in terms of each criterion. The rating scheme provides comparable measures for each criterion, and it prevents one criterion or a small group of criteria from dominating the selection process.

The other approach uses natural quantitative measures for each criterion. Thus, accessibility might be measured



Example of Natural Rating Measure (passengers/ vehicle hour)



Example of Scaled Incremental Rating Index (0-100 scale)

(Source: N.D. Lea, Reference 46)

CRITERIA VALUES FOR ALTERNATIVE TRANSPORTATION SERVICES

Criteria	Units	Alternative Transportation Services: Fixed-Route Bus	Flexibly Routed Bus	Dial-A-Ride Many to one	Regular Taxi	Shared-Ride Taxi Many to Many	Jitney	Pooling: Van	Pooling: Car	Private Auto
Service Area	Sq. Miles	20	25	24	120	40	3	386	386	386
Access Distance	Feet	1000	600	50	50	50	100	50	50	150
Availability	Minutes	60	60	20	15	20	4	Scheduled	Scheduled	5
Travel Time	Minutes	30	35	25	15	20	20	20	20	15
Cost/Trip	Dollars	.35	.45	2.10	3.40	1.75	.30	.40	.25	1.25
Patronage	Daily Riders	550	700	1000	1100	2000	3000	1500	2000	132,000
Purpose	Trip Type	Work Personal Bus.	Work Personal Bus.	Personal Bus., Shopping	Work Personal Bus.	All	Shopping, Personal Bus.	Work	Work	All
Automobiles Released	Number	None	10	30	None	100	None	750	750	None
Profit Potential	Relative	Loss	Loss	Loss	Moderate	Moderate	Moderate	Break Even	Break Even	Loss
Vehicles Required*	Number	4**	5	36	60**	50	20	75	250	131,200**
Investment	Dollars	240,000	300,000	288,000	180,000	150,000	140,000	525,500	1.4 million	720 million
Hours of Service	Time	6:00 AM 7:00 PM	6:00 AM 7:00 PM	8:00 AM 5:00 PM	24 hr	9:00 AM 7:00 PM	10:00 AM 6:00 PM	Specific Scheduled	Specific Scheduled	24 hr
Promotional Requirement	Relative	Little	Extensive	Extensive	Little	Moderate	Moderate	Extensive	Extensive	None
Type of Owner	Private or Public	Public	Public	Public	Private	Private	Private	Private	Private	Private
Impact on Bus	Riders/day	0	+150	0	0	-50	0	0	0	0
Impact on Taxi	Riders/day	0	0	-100	0	-300	0	-100	-150	0
Capital Cost	Dollars	18,000	60,000	57,600	0	800	0	0	0	0
Financial Risk	Relative	High	High	High	None	Low	Low	Low	Low	None
Service to Agencies	Yes or No	No	No	Yes	Yes	Yes	No	Yes	No	No
Business Stimulus	Relative	None	None	Some	Some	Some	Moderate	Some	Some	None
Reduced Congestion	Relative	None	None	None	None	Little	Moderate	Little	Little	None
Reduced Pollution	Relative	None	None	None	None	Little	Little	Some	Some	None
Energy Efficiency	Passenger Miles/Gallon	17	17	5	7	10	15	53	30	14

* For fully developed service
** Current service level

(Source: Stanford Research Institute, Reference 47) in terms of mean access distance in feet; patronage in expected number of riders; capital cost in dollars; service to social service agencies in customers carried; and so forth. This method has the advantage of allowing the planner to estimate all criterion values, since they are not judgment-based. However, numerical measures must be normalized to avoid dominance by one or a few criteria. (See Reference 49 for a discussion of normalizing.)

(ii) Select Criterion Weights. Criterion weights also pose a difficult problem. Clearly, all criteria do not have equal values. In some, the subsidy per rider may be more important than on-time performance; to others, service hours may be less important than mean travel time. Each participant could produce a different rank ordering of the criteria. Criterion weights can be established by interaction within a group that represents all of the participants. It can be accomplished in an informal manner using a DELPHI technique. Alternatively, individual sets of weights can be produced using a computer program to help the participant set weights that are consistent with his perception of the relative importance of known projects. By the interactive scheme, the participant sets initial weights for all of the evaluation criteria. The computer tabulates scores for the known projects and gives the participant the results. If the participant does not agree with the results, he can modify some or all of the weights and try again. When he is satisfied with the result, he accepts the weights that produced that result. This is a slow process, but it can yield good results.

Where possible, the following rules should be observed in assigning weights to criteria (Reference 46):

- Weights should reflect ratio relationships. If Criteria 2 is three times more important than Criteria 1 and six times more important than Criteria 3 and 4, then the weights should reflect this.

- It is permissible for two, three, or more criteria to have the same weight.

- Assigning weights to criteria is an exercise that is independent from the development of alternatives. In an objective evaluation (with the purpose of selecting the best alternative), weights should not be assigned with the intention or purpose of favoring one alternative over another.

(C) Execute Scoring Model

If the scoring model is designed to produce acceptable criterion values and weights, the execution of the model is straightforward:

- Rate each criterion for each alternative;

- For each alternative, multiply the criterion value by its weight;

- Add the rate-weight products for each alternative; and

- List all alternatives in descending order of rate-weight sums.

The first alternative on the list is preferred; the next is second; and so forth. The top alternative is not automatically selected; other factors are invariably considered, but the ranked list is a useful tool for the decisionmaker.

However, if ratings and weights stir up more controversy than they resolve, there is another approach to execution that is sometimes useful: pairwise comparison. This process is illustrated in the exhibit on Criteria Values. In this instance, no satisfactory panel could be assembled to prepare ratings and weights. Therefore, the planner calculated criterion values for each alternative using the units of measure listed in the exhibit.

The criteria values were sufficiently diverse that direct comparisons among all nine alternatives were not possible. However, it was possible to make a systematic comparison between pairs of alternatives. The procedure followed is:

1. Select two alternatives for comparison;

2. Make a side-by-side comparative list of all 23 criterion values for each of the two alternatives.

3. Select the first criterion; compare criterion values for the two options. If the values are indistinguishable, cross out the criterion. Continue this process for all 23 criteria.

4. Make a new list of the surviving criteria together with the criterion values for the two options.

5. Weigh the relative values of the criterion differences to determine which option is preferred.

For example, consider the comparison between flexible-route bus and dial-a-ride. The differences in the two systems are marked for the following criteria:

Criterion	Flexible-Route Bus	Dial-A-Ride
Access distance	600 feet	50 feet
Time availability	60 minutes	20 minutes
Travel time	35 minutes	25 minutes
Cost per trip	$.45	$2.10
Patronage	700/day	1000/day
Vehicles required	5	36
Impact on existing bus	+150 riders/day	0
Impact on taxi	0	-100 riders/day
Service to agencies	no	yes
Business stimulus	none	some
Energy efficiency	17 pax.mi./gallon	5 pax.mi./gallon

It is necessary in this instance to carry both options forward to the next step of the analysis, as each service shows merit.

The facing exhibit shows the results of the pairwise comparison of the various transit options in a specific setting. In this comparison, automobile, vanpool, jitney, and shared-ride taxi are the preferred options. The planner would therefore pass these options onto the next planning step. These results are site-specific, and cannot be generalized on the basis of the work performed.

RESULTS OF PAIRWISE COMPARISON

Service	Private Automobile	Car Pool	Van Pool	Jitney	Shared-Ride Taxi	Taxi	Dial-a-Ride	Flexibly Routed Bus	Fixed-Route Bus
Fixed-Route Bus	Private Automobile	Car Pool	Van Pool	Jitney	Shared-Ride Taxi	Taxi	Dial 'A Ride	Flexible Route Bus	
Flexibly Routed Bus	Private Automobile	Car Pool	Van Pool	Jitney	Shared-Ride Taxi	Taxi	T		
Dial-a-Ride	Private Automobile	Car Pool	Van Pool	Jitney	T	Taxi			
Taxi	Private Automobile	T	T	Jitney	Shared-Ride Taxi				
Shared-Ride Taxi	Private Automobile	T	T	T					
Jitney	T	T	T						
Van Pool	T	Van Pool							
Car Pool	T								
Private Automobile									

T = tie

Communities selecting paratransit services other than Dial-a-Ride or Shared-ride taxi should refer to Appendix 5 for additional information.

(Source: Stanford Research Institute, Reference 47)

Go to A-5 Alternative Paratransit Systems

(D) Interact With Citizen Groups

It is wise to circulate the results as widely as possible. Solicit citizen reaction to the steps outlined; the exhibit suggests some methods for this solicitation.

Hold workshops with key citizens and citizens from key groups. Be sure they are workshops rather than one-sided presentations. Explain the material, then initiate discussions of the alternatives and their relative worth. Use small group processes. Encourage new alternatives to be proposed, or revised versions of existing alternatives. Be prepared to evaluate these on the spot. Draw the workshop to a conclusion, if possible. If not, schedule another. This is a slow, painful process, but if properly executed, it can avoid a great deal of trouble later, when more is at stake.

When satisfied with the workshop results, prepare a summary of the process and the conclusions. Give this wide circulation. Finally, when a clear consensus is apparent, call a public hearing. A "show and tell" presentation at this time will be both effective and rewarding, and will contribute to the final decision process.

SOLICITING CITIZEN INPUT

- On the basis of all previous functions, select those several feasible systems which best meet all stated objectives and constraints.
- Prepare a concise description with simple graphics of how well each alternative system rates, and distribute to public.
- Present to citizens' advisory group.
- Make oral presentations at several public hearings and in several geographic locations if service area is large.
- Document all public comments for decisionmakers' use.

(Source: SYSTAN)

2.2.13 Select and Describe Candidate Systems

No more than four different alternatives should be presented to the decisionmaking body for final selection. Each alternative system should reflect a distinct choice. This is no place to deal in fine differences between closely-related alternatives; such differences can be sorted out during the design phase.

(A) Collect Screening Results

It is likely that citizen groups will raise new issues and options that had not previously been considered. All specific citizen inputs need not be dealt with at this time, but they should not be forgotten. Some techniques for resolving differences are:

- If a suggestion improves service to a target group without appreciably increasing estimated cost, incorporate it.
- If a suggestion improves service but at a clear cost increase, consider adding it as part of an additional alternative.
- If two suggestions regarding a single alternative conflict, the alternative may be carried through the planning decision process without specifying which suggestion will be accepted. Final resolution will come during the design phase.
- Drop alternatives that rated low and had little citizen appeal. A complete spectrum of alternatives is not needed here.
- List and summarize the surviving alternatives. Look for distinct conceptual differences between them. If two alternatives are conceptually similar, drop one from consideration at this time.
- Frequently review evaluation ratings, making changes where appropriate. Consider weights; do they really reflect the interests of the participants?

(B) Describe Alternatives

After reworking the alternatives and incorporating citizen suggestions, a complete summary should be written describing:

- Service areas
- Boundaries
- Type of service
  - Conceptual vehicle
  - Type of movement
  - Control
  - Service level
  - Schedule constraints
- Hours of operation
- Ownership
- Labor source and terms of employment
- Maintenance procedures
- Integration with other services

Include in the summary the viewpoints of different participants to the transportation-improvement process, such as users, operators, businesses, local community, and local government.

2.2.14 Prepare Design and Implementation Schedule and Budget

At this point, estimates of cost and time required for the design and implementation tasks should be made and presented to decisionmakers. They will need this information to decide whether or not the project will move beyond the planning stage. The additional cost of acquiring and operating the system should be presented in terms of the rough estimates developed earlier (Section 2.2.10), but detailed figures are inappropriate until detailed design has been undertaken.

One approach is to prepare a time schedule and budget for each stage. It should be pointed out that the figures for design will be more reliable than the estimates for implementation, which will depend on the outcome of design. Rough estimates from existing system information indicate that the design stage can take from 1½ to 4 months; implementation from 1 month to over two years. The length of time can be affected by:

- The size of the service area;
- Urban or rural setting;
- Complexity or simplicity of institutional arrangements;
- Complexity or simplicity of system design; and
- Number of origins/destinations to be serviced.

While it may be difficult to estimate the length of time, it must be stressed that this does not eliminate the need for determining a specific time schedule for each of the tasks. In the process of getting the project organized and setting forth a work program, it is essential for the core staff to estimate the amount of time they expect it might take to do each task. To do this effectively requires that a detailed list be made of every task, stating how many days each might take. Using this as a rough estimate, one can develop a general schedule for carrying out the design and implementation.

More information is needed to make associated cost ranges for these two stages. Sample costs for two small communities ranged from $15,000 to $25,000 for design and implementation.

2.2.10
Rough Estimates
of Cost

2.2.14

BUDGET

					DESIGN COST ESTIMATES	IMPLEMENTATION COST ESTIMATES
(See Section 3.0 for Design and Section 4.0 for Implementation tasks)						
PERSONNEL*						
Type of Staff Needed**	Cost/Hour		Estimated Number of Hours			
• ______	$ ______	X	______ HOURS	=	$ ______	$ ______
• ______	$ ______	X	______ HOURS	=	$ ______	$ ______
• ______	$ ______	X	______ HOURS	=	$ ______	$ ______
• ______	$ ______	X	______ HOURS	=	$ ______	$ ______
OVERHEAD COSTS						
Telephone					$ ______	$ ______
Printing					$ ______	$ ______
Mailing					$ ______	$ ______
Equipment					$ ______	$ ______
OUTSIDE ASSISTANCE						
Design Consultant					$ ______	
Marketing Experts					$ ______	$ ______
Training Assistance					$ ______	$ ______
Other						
TOTAL COST ESTIMATE					$ ______	$ ______

*Dependent on who will do design and/or implementation
- -Consultant (fee)
- -In-house staff
- -Additional staff may be hired

**Relate staff time to tasks
Additional time should be budgeted for work and meetings with advisory group, community, etc.

Task 4.2.1 Apply for Funds may vary from a simple revenue sharing allocation to a time consuming federal grant application process.

SAMPLE PRESENTATION OUTLINE

Presentation Materials

Area: The Heights, California
Service Area Size: 6 sq. miles
Population: 26,000
Population/sq. mile: 4,300

Service Area: entire city

Service objectives: transit service for general public, but primarily for elderly and handicapped.

How many will ride? 300 passengers/weekday
range: 200 to 400 passengers/weekday

Proposed service option: dial-a-bus
- many-to-few: peak, off-peak hours
- many-to-many: shuttle for shoppers during off-peak hours

Where does the money come from?
Fares: $10,000
State: $280,000 (Source: SB325)
City: $ 5,000 (Source: revenue-sharing)

Basis/Back-Up Materials

	Section:
. Preliminary talks with advisory and community groups	2.2.6
. Assessment of existing service	2.2.1
. Identification of transit needs of city's elderly and handicapped	2.2.2 2.2.3
. Looked at other systems	A-4
. Worked through rough demand-estimating techniques	2.2.10
. Alternatives considered with input from community workshops: - Loop bus system - Fixed-route bus - Subsidized taxi	2.2.12 2.2.13
. Looked at other systems	A-4

Presentation Materials

Where does the money go?
Capital costs: $132,000
Operating costs: $163,000/year
$ 2.00/passenger (estimated)

Funding sources:

Transportation Development Act (SB325)

- Available for capital and operating funds
- Application required, due by April 1 for FY funding
- Requirements/Limitations: coordination with existing transit system (countywide fixed-route bus).

Vehicles: 100 seats needed
Six 15-passenger vans are indicated; advise purchase of three to start; lead time to order: 2 months

Operator: City operation

- Capabilities exist within city
- Integration of facilities, equipment, control center possible
- No major purchases necessary outside of vehicles

Basis/Back-Up Materials

. Have a rough breakdown of operating costs available

. Preliminary discussion with regional authority that approves application and channels funding

. Potential transfer points at 2nd and San Antonio; 8th and Oak.

2.2.10

. Technical material relating number of vehicle seats to population, etc.

. Held preliminary talks with taxi companies
. Assessed city staff
. Management firm estimate considered

Presentation Materials

Hours of operation:

Mon.-Fri.: 7 a.m. to 7 p.m.
Saturday : 10 a.m. to 4 p.m.

Fare: many-to-few : 50¢
many-to-many: 75¢ regular
25¢ elderly & handicapped

Other operational considerations

- Labor: drivers
- Marketing: city staff
- Ordinances: no changes necessary
- Licenses, permits: application to FCC necessary for radio channel unless possible to share one with fire department

  Lead time: 2 months if new channel needed
- Insurance: umbrella policy possible

Precedents: comparable system operations exist in areas of similar size, population, and density

Basis/Back-Up Materials

. Looked at other systems	A-4
. Higher fare to constrain demand; easier to lower fare later	2.2.9
. Talks with local union indicate no problems; preliminary discussion of work rules has taken place	2.2.4
. Talk with insurance company representative handling city insurance	
. Systems # 4, 29, 42, 47, 68, 74	A-4

2.2.15 Present Plan Proposal

At the end of the planning stage, one should have enough information to make a preliminary assessment of the proposed system. If it is satisfactory, it is ready for presentation to both the decisionmaking boards or councils and the community. Make the most of this opportunity to garner support for the proposal and to test its feasibility. The presentations should realistically convey a sense of what the system will look like; its objectives and the benefits to be derived by the community; how much it will cost and where the money will come from; how it will operate; and, to allay fears of introducing exotic, untried schemes, reports of similar operations in other cities. The presentation outline in the exhibit is an example developed to indicate the types of information to be presented, the material needed to support the proposal, and the planning section in the guidelines where such material is discussed.

Try to document any discussion of the proposal and general reception of the presentation for future use in either revising plans or considering design.

OBTAIN APPROVAL FOR DESIGN

Formal approval needs to be obtained before design work can begin. Following the presentation of the sketch planning proposal, the decisionmaking body has several options:

- To approve the system concept and move on to the specific design stage;
- To rethink the proposal, asking the planner(s) to provide partial revisions of the concept and resubmit the proposal to the council for approval; or
- To reject the concept.

2.3 Planning Pitfalls

This section summarizes the major pitfalls to be avoided in planning paratransit systems.

UNREALISTIC OBJECTIVES

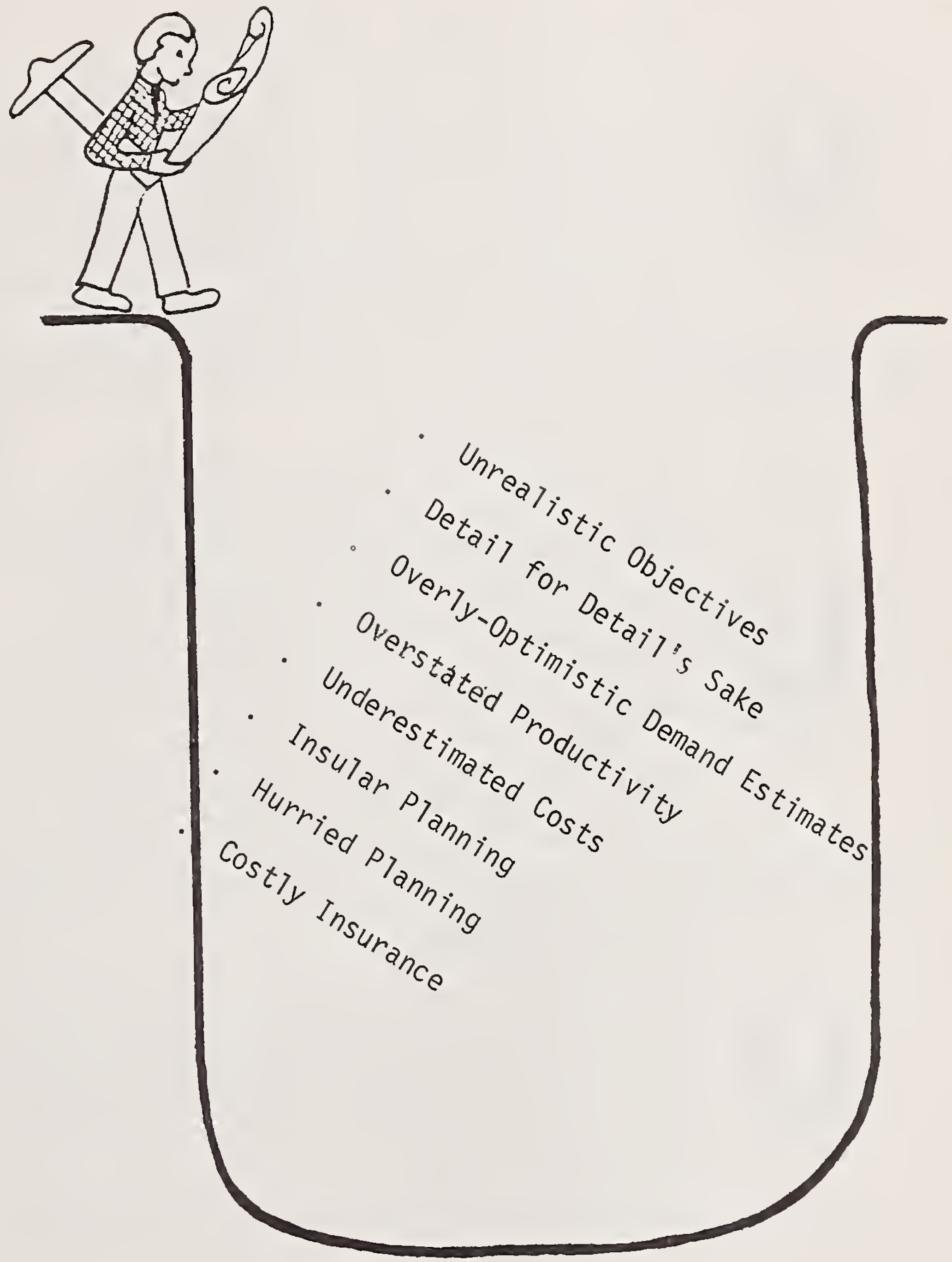
Paratransit systems are not likely to make significant inroads in conserving energy, reducing air pollution, or influencing land use. Early recognition of this fact may help to stave off later disappointment and criticism.

DETAIL FOR DETAIL'S SAKE

The temptation to become bogged down in minute data and detailed modeling should be avoided in the planning phase. To date, detailed planning models have performed no better than simple rules of thumb in predicting paratransit system performance.

OVERLY-OPTIMISTIC DEMAND ESTIMATES

Early studies of the economic feasibility of dial-a-ride systems typically overstated demand by one or two orders of magnitude, leading to overly-optimistic assessments of system feasibility.



OVERSTATED VEHICLE PRODUCTIVITY

Early modelers tended to ascribe higher productivity rates to vehicles than later experience has shown to be likely. Median productivities on U.S. systems are six passengers per vehicle-hour, and no U.S. system has exceeded ten passengers per vehicle-hour, although Regina, Canada experiences productivities of fifteen.

UNDERESTIMATED COSTS

For a variety of reasons, including inflation, delays, and poor planning, paratransit costs have historically been underestimated. This is particularly true of per-trip costs, which have been affected by optimistic demand and productivity estimates. The relatively high cost of personal service (median of $1.78 per passenger for general market systems) should be recognized in advance, and allowances should be made for inflation and unforeseen contingencies.

INSULAR PLANNING

Failure to involve private operators and the public in the planning process can be fatal. In Santa Clara County, opposition and a pending lawsuit from taxi operators proved to be one of the straws that broke the system's back.

HURRIED PLANNING

One system reported that their service suffered from hasty planning due to citizen pressure to "get the show on the road." The one-month planning period that resulted led to a costly and inefficient system. Other systems have reported poor results stemming from political pressure during the planning process.

INSURANCE

Insurance is costly, and may be difficult to obtain. Determine requirements, availability and costs early in the planning process.

3.0

3.0 DESIGN

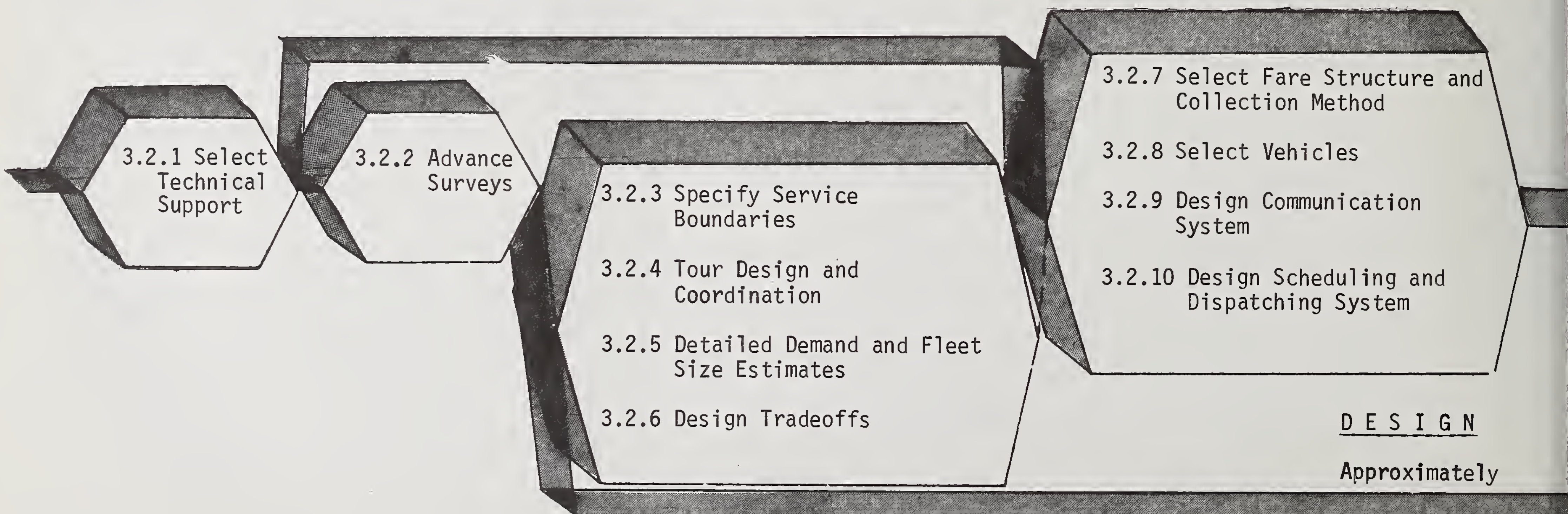
In the context of the five-stage PDIOE process defined in these guidelines, the second stage--Design--translates planning decisions concerning desirable system concepts and policies to the details of hardware, system boundaries, staffing, fare collection, operating rules, and other elements associated with the specific services offered. Therefore, a number of the functions described in the previous planning stage are treated in further detail within this section. In addition, many issues which could not be raised during the initial planning stage, such as the selection process for vehicles, communications equipment and facilities, will be outlined and discussed in the design guidelines.

Communities contemplating small experimental systems may wish to bypass many of the elements of the detailed design stage entirely and proceed directly to system implementation.

3.1 Overview

3.1.1 Functional Tasks

The design stage begins with approval of one or more alternative plans and ends with the approval of the design and implementation budgets, just before finances are committed to capital equipment. The stage can include each of the functions sketched below, although several tasks may be bypassed. In general market systems, the requirement for advance surveys is marginal, and can usually be bypassed. Also, in smaller systems the preliminary demand estimates made in the planning stage may be adequate for design purposes.

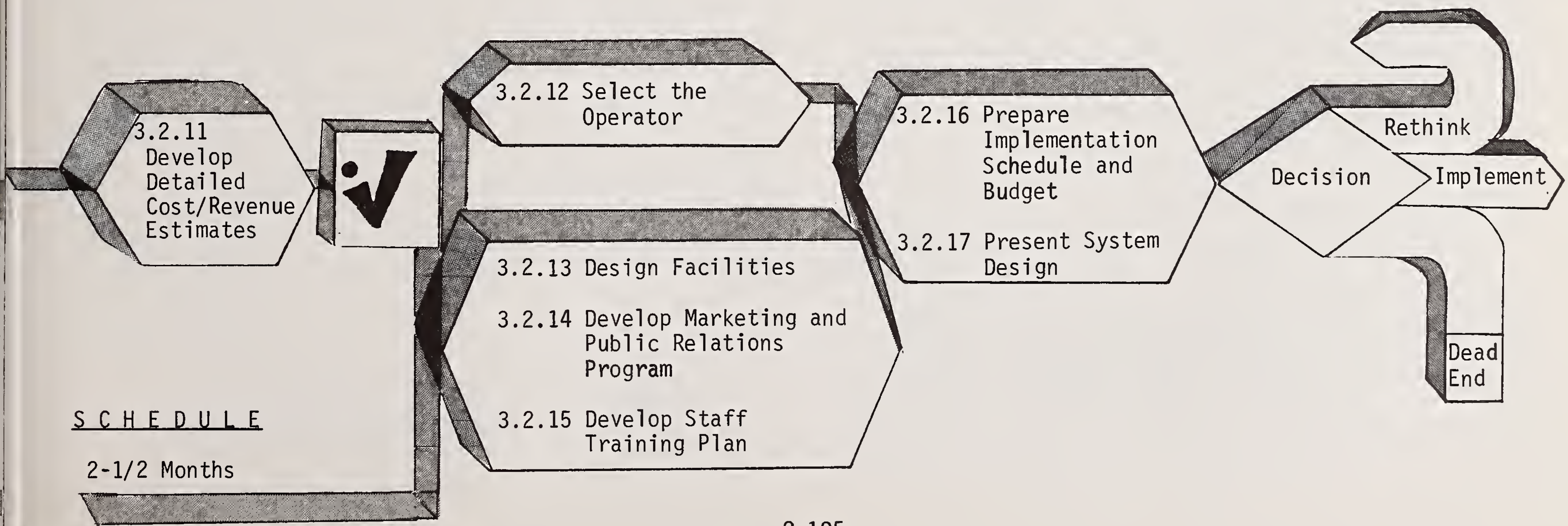


Once the tasks identified below have been adopted to fit local needs, precedence relationships can be developed and scheduled to provide a control tool for the design process.

The most important elements of the design stage focus on the specification of service parameters, tour design and coordination, and the establishment of operating rules and control procedures. Once these elements have been resolved, vehicles may be selected, facilities may be designed, a marketing strategy may be laid out, and a detailed cost budget can be prepared for review prior to implementation.

3.1.2 Timing

The Canadian Dial-A-Bus Manual (Reference 4) estimates the length of the design process as seven weeks to four months, with an expected value of ten weeks. Data on U.S. experience is somewhat sketchy, but it appears that this time frame is consistent with the experience of systems that are not federally funded. Reliance on federal funding typically stretches the time required for both the design stage and the subsequent implementation process. The state-supported Michigan systems, on the other hand, report an average of only three and one-half months for the combined design and implementation process.



3.1.3

3.1.3 Analytic Notes

Design requires more specific decisions than planning, and some functions may benefit from detailed analysis and the use of more quantitative data and models. This is certainly true of the system design and cost estimation processes. Demand estimates should be revised to reflect more detailed design knowledge, but it has not been demonstrated that more detailed demand models are any more accurate than simpler approaches. The use of sophisticated simulations in design can lengthen the time required for design and implementation. The two U.S. systems using this approach, Haddonfield and Rochester, required more than two and one-half times as much time for design and implementation as any other system, although other factors also contributed to the delays encountered.

As in the case of planning, the degree of analysis and approaches taken in the design process will vary from site to site, depending on such factors as data availability, available expertise, system complexity, the size and population of the service area, available funding, and integration requirements.

3.1.4 Data Required and Sources

Once the particular service type and area have been determined, more extensive and more specific data will be needed to complete the design phase. The data needs can be broadly divided into four categories: (1) site characteristics, (2) demand estimates, (3) equipment characteristics, and (4) labor characteristics.

This section addresses the general types of information required in the design process. Specific data needs are covered in the procedural sections devoted to each design task. Thus, the Vehicle Selection section (Section 3.2.8) covers Equipment Characteristics, while the Demand Estimation section (Section 3.2.5) covers detailed data requirements for demand estimates.

(A) Site Characteristics

The designer should have "on-site" familiarity with all of the service areas for which he is designing demand-responsive services. In addition, the designer will have use for most or all of the data listed at the right. Adequate population data can be obtained from census tracts. However, specific locations are needed for employment, commercial sales, government offices, and services. Church parish, school district, and development boundaries are important because they tend to divide social neighborhoods. Traffic flow data for all major streets in the area will identify traffic barriers. Data on existing transit and taxi services should include service area boundaries, frequency of service, fares, patronage, routes, operating costs, service reliability, schedule performance, and other data that can be obtained from the operators. Past surveys should be collected for whatever information they contain regarding travel patterns and modal preferences.

3.2.8 Vehicle Characteristics
3.2.5 Detailed Data Requirements for Demand Estimation

D

DEMAND DATA AND SOURCES

SITE DATA	POSSIBLE SOURCE
Census data by tract on Population Trip-to-work characteristics Employment Income Education	Census of Population
Employment Manufacturing Commercial	Chamber of Commerce Directory of Manufacturers Retail Associations
Commercial Sales	State Sales Tax Records
Government Offices	
Services Medical Professional	City Directory, Professional Directories
Churches Parish boundaries	Church Officer
Schools District Boundaries	Board of Education
Development Boundaries	Recorder's Office
Traffic Flow by Street	Traffic Engineer
Existing Transit Service	Transit Operator
Existing Taxi Service	Taxi Operator
Survey Data Past origin/destination surveys	As Available

(Source: SYSTAN)

(B) Demand Estimates

Accurate estimates of demand for new demand-responsive services are desirable, but almost impossible to obtain. The facing exhibit lists possible types of data and likely sources. All existing data should be collected and analyzed before new data collection efforts are launched.

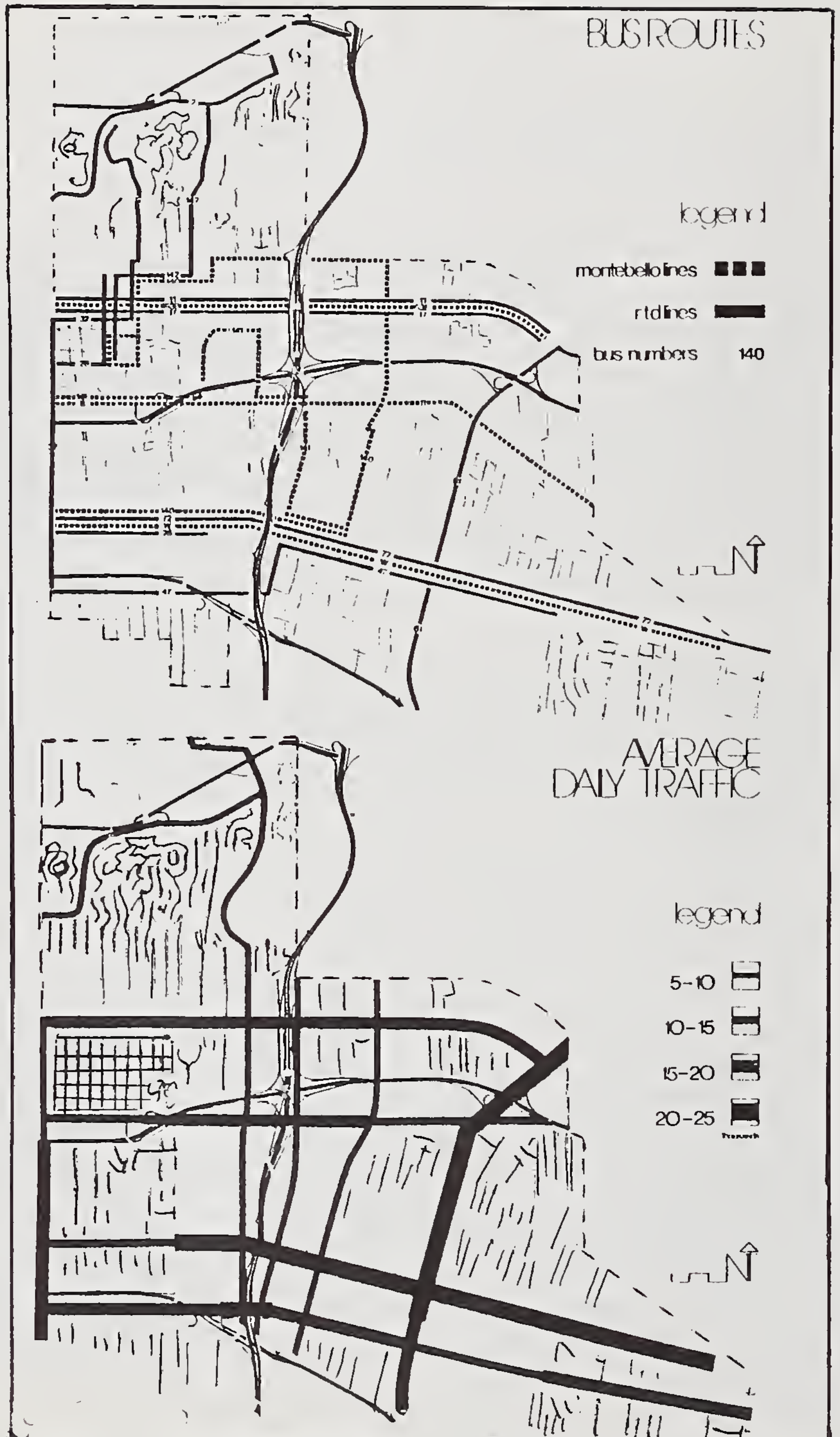
The areawide comprehensive planning study is a useful source of information. The transportation zones that were selected for the comprehensive planning study are useful building blocks. Zones can be combined into service areas that warrant preliminary considerations. By using combinations of planning zones, travel data can be assembled from the planning study and organized by purpose and mode. However, numerical data on trip origins and terminations, travel volumes, and mode share should be used with caution.

Employment data, by zone of residence only, can generally be collected from employers in the service areas. Social welfare agencies will also give the zone of residence of their patrons, and can often supplement this with data on the nature and frequency of specific transportation needs.

Transit and taxi patronage data should be collected, even though the information usually falls short of what is needed. Transit and taxi data are generally derived from fares that bear no relation to trip origins and destinations. Some transit operators perform on-board surveys which identify passenger loads and major boarding and deboarding points.

Past patronage surveys should be collected and used to the extent possible. New surveys should be with caution. Because demand-responsive patronage is low, general surveys of the service area population have little value, if any. Cheaper and more useful surveys can focus on potential users by going to minor activity centers and

3.1.4



(Source: Barrio Planners, Reference 32)

major mode transfer points, such as shopping centers (or in target market areas, social service agencies, recreation centers, and the like). It must be kept in mind, however, that such surveys cover a biased sample of the population.

(C) Equipment Characteristics

Equipment characteristics are vital to new service design because they influence both performance and cost. Data are needed on vehicle and communication equipment as well as any aids to vehicle dispatching. See SCRAPS Section 1 and 3 for lists of vehicle and radio specifications that should be considered.

(D) Labor Characteristics

Labor is the largest single component of service cost. It is therefore imperative that something be known about the supply, skill, restrictions and cost of an operational staff. Information can be obtained from existing operators, union representatives, chambers of commerce, employer groups and others. Items of interest include:

- Working hour restrictions (shift premiums, split-shift restrictions, overtime, overtime premiums, part-time, call-in time).
- Job assignment procedures. (It could be a disaster if the dispatcher's job is subject to bidding.)
- Grievance procedures. (How much control has the operator?)
- Wage scale.

These items will have a significant influence on the service design. Care should be taken not to commit the service to a particular type of labor before the design is completed.

1 Vehicles

3 Communications Equipment

3.2 Procedures

3.2.1 Selecting Technical Support

Demand-responsive services encompass a wide variety of personnel arrangements, ranging from the independent and traditional "mom and pop" taxicab operation to the structured union shop of conventional transit systems. The system's size, type and complexity will usually determine its basic staffing requirements.

Design and operational staffing needs are interrelated and should be identified early in the design stage, although the final operator selection will not be made until midway through this phase. Prior experience with demand-responsive operations emphasizes the importance of developing a strong nucleus of committed individuals who will see the project through to actual operation. The lack of strong, committed leadership can result in a service that never gets off the drawing board.

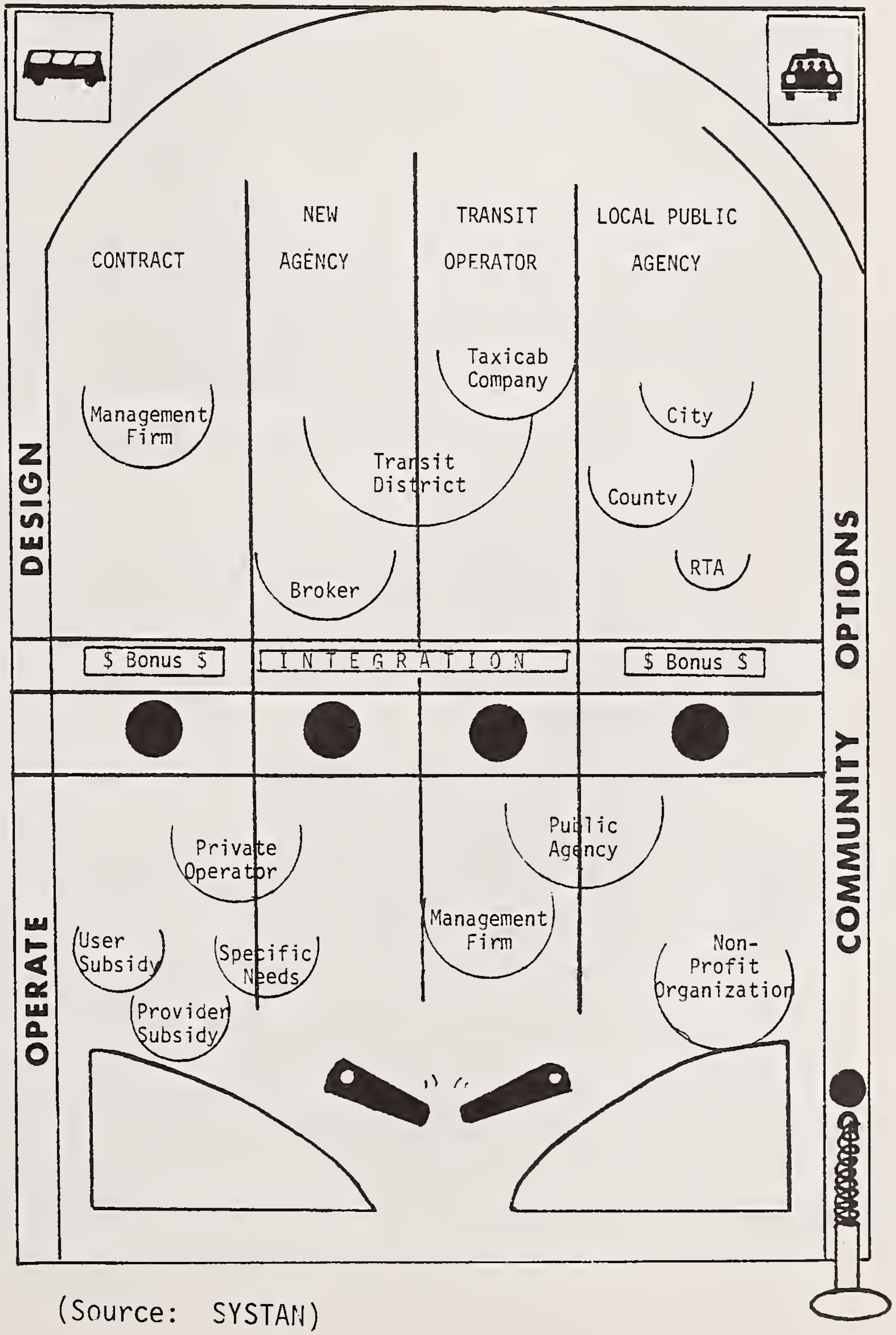
From the community's perspective, the first issue to resolve is whether to contract for services or provide them in-house. This will depend upon:

- State and community restrictions and policies;
- Service options selected;
- Community capabilities;
- Organizational options available;
- Costs of alternative options;
- Benefits of alternative options; and
- Funding sources available.

(A) State and Community Issues

Community objectives (Section 2.2.1) should be reviewed and matched against prior and existing municipal service arrangements to determine future contract policies

2.2.1
Local Needs and Objectives



(Source: SYSTAN)

and bidding procedures. If no precedent exists, confer with another community like yours about establishing policy. State laws should also be reviewed before proceeding.

(B) Community Capabilities

The first step is to assess how well existing personnel and resources fill the system's needs and identify any remaining gaps. Outside support can then be considered to help in filling these areas.

Investigate the following community resources:

- Local Public Agencies
  - City government
  - County government
  - Municipal planning organization (MPO) or other regional agencies
  - Other community agencies
- Local Operators
  - Public transit authority
  - Private bus companies
  - Private taxicab companies
  - Other local operators (e.g., limousine, jitney, schoolbus)
  - Non-profit organizations
  - Private management firms

For each feasible option, identify:

- Number and type of staff (e.g., technical and managerial experience);
- Current services provided;
- Excess or available facilities and equipment (e.g., dispatching center, vehicles);
- Institutional constraints (e.g., funding and service area restrictions);
- How would the option be received by the community? (particularly in the targeted service area);
- How would it be received by other operators?

Planning data describing existing conditions and identifying participants will be useful at this point.

Although no hard-and-fast rules exist for determining the specific design and technical staffing requirements, if the existing staff had trouble with the planning phase, they are likely to need help with the design phase.

A cautionary word about making separate contracts for a number of design and operating tasks: Dilution of control and multi-level decisionmaking can lead to confusing operating situations. KEEP IT SIMPLE!

To determine the extent of contractual needs, match available personnel to the appropriate design, implementation and operating tasks. Note those design tasks that are not covered by in-house staff. Look for gaps in local operating capabilities as well.

(C) Technical Support Outside the Community

Outside technical support may be available from the state. State programs range from elaborate grant application, feasibility and marketing study assistance to simply dispensing advice over the telephone. For example, the State of Michigan offers complete planning, design, implementation, and operating aid to local communities wishing to establish demand-responsive transit services. SCRAPS Section 7.2 contains a list of the types of state technical assistance available.

Technical management and consulting firms can also provide staff support for system design and operation, or only for those areas where in-house capability is lacking. If consultants are used only in design, arrange a staffing transition stage from the design to the implementation phase.

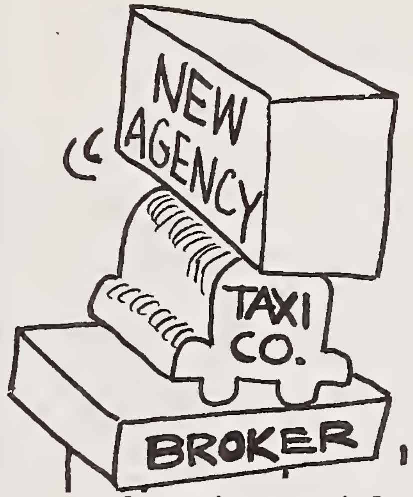
Although existing operators could be used to design the demand-responsive service, it is probably preferable to seek a more objective designer if the community is not sure what type of system it really wants or needs. Ideally, find someone who can assess the individual community needs and objectives, yet understands and encourages input from existing operators.

(D) Operator Options

Check the subsequent exhibit of community organizations for options in both the design and operation phases.

<u>(i) Public Agency</u>. The most prevalent arrangements favor the local public agency's active involvement during the design phase, with private operators or public transit authorities providing the actual services. A common

7.2
State Funding
Offices



Questions and Issues to Consider

- Should a single operator or agency provide all services? Watch out for vested operator interests; avoid biasing operations in favor of unsuitable existing service.
- Should several operators or agencies provide all services? Should each provide one type of service, or more than one? Avoid creating unnecessary layers of agencies.
- Can these be coordinated or integrated? Experience shows that new services are often easier to coordinate than existing ones.

alternative is for the system to be developed and operated by one group of technical and operational experts.

National figures show that many systems are now using the public agency option; this bias can be credited in part to Michigan which offers to cities initial technical and financial aid. Based on their success, it appears that organizational needs can best be served through a local body that can offer technical experience, can adapt to a new service, and has previous transportation know-how (Reference 40). Most municipal transit departments operate on an equal footing with other city or county departments, with the city council controlling their rates, fares and general operating policies. It may be possible to establish a new paratransit agency within the local administration; however, if a transit division already exists, try to integrate organizational and service needs.

Contracting with a public or private organization to obtain operating capability provides a quick means of obtaining the skills necessary for system start-up. This device can be used to contract for general skills or to cover specific functional areas (e.g., maintenance), thus eliminating the need to locate and hire additional experienced operating personnel. Most demand-responsive transit operations should seriously consider contracting for heavy maintenance and road service with a municipal transit system garage, or making arrangements with a private automobile repair shop.

OPTIONS FOR DESIGN AND OPERATIONS

DESIGNER	OPERATOR	EXAMPLES OF EXISTING SYSTEMS
* Local public agency designs	and operates	GM: Big Rapids, MI TM: Tucson, AZ
* Local public agency designs	contract with local private operator (eg. taxicab company)	GM: St Bernard Parish, LA TM: Palo Alto, CA
* Local public agency designs	contract with local public operator (eg. transit authority)	GM: Houghton Co. MI TM: Worcester, MA
Local public agency designs	contract with management firm	GM: Tracy, CA
Local public agency designs	contract with non-profit agency	TM: Spokane, WA
* Transit authority designs	and operates	GM: Santa Clara Co., CA TM: Topeka, KS
Transit authority designs	contract with local private operator (eg. taxicab company)	GM: Orange Co., CA TM: Cleveland, OH
Transit authority designs	contract with management firm	GM: La Habra, CA
Establish new agency to design	and operate	GM: Ann Arbor, MI
* Contract with management firm to design	and operate	GM: Fairfield, CA
Contract with management firm to design	contract with local private operator (eg. taxicab company)	GM: Niles, MI
Contract for specified areas of deficiency (eg.staff training maintenance, marketing, etc.)		GM: Gaithersburg, MD.
Establish broker capabilities		GM: Knoxville, TN TM: Mt. View, CA
Other contracts with existing paratransit operators (eg. user-subsidy provider-subsidy)		Danville, IL Los Gatos, CA

*Most common existing arrangements

(Source: SYSTAN)

(ii) Public Transit Authority. Some systems, particularly general market systems, have contracted with public transit authorities to obtain operating capabilities. This avenue can make a wider variety of funding sources available. Public transit authorities can also provide for their transit districts a secure tax base, assurances of continued operations, and a board whose sole responsibility is transit (Reference 41).

Although transit authorities may be an excellent means of providing an integrated public transit service, this option is usually not available in small urban and rural areas. The time, expense, and general lack of public support for those programs that require additional taxation raise further doubts as to the prospects for creating any new transit authorities. The accompanying exhibit shows the number of steps necessary to create a transit district in California; these steps may differ from state to state (Reference 41).

Unfortunately, some transit operators are also skeptical of any changes in their present organizational structure. They have shown resistance to initiating demand-responsive service in-house, fearing a "drain in patronage from existing operations" (Reference 101). While demand-responsive service, if properly designed, should enhance rather than compete with other transit services, many communities have found they were unable to afford the high union wages demanded by public transit authorities. San Diego, California determined that cost-effective demand-responsive service was impossible if driver wage and benefit levels exceeded $6.00 per hour. With the city and county transit authority operators demanding approximately $8-$11 per hour, operating options were limited to local government agencies or private bus and taxicab companies.

GENERAL STEPS IN CREATING A TRANSIT DISTRICT

LEGISLATION AUTHORIZING FORMATION OF TRANSIT DISTRICT IS PASSED

STEP 1: ENABLING LEGISLATION

LOCAL GOVERNING BODY (CITY COUNCIL AND/OR BOARD OF SUPERVISORS) PASSES RESOLUTION APPROVING TRANSIT DISTRICT

STEP 2: LOCAL POLITICAL APPROVAL

MEASURE VOTED ON BY RESIDENTS OF PROPOSED TRANSIT DISTRICT, IF A LOCAL PROPERTY OR OTHER TAX IS INVOLVED

STEP 3: ELECTION

IF APPROVED BY ELECTORATE, A TRANSIT DISTRICT IS CREATED AND A GOVERNING BODY FORMED

STEP 4: ESTABLISHMENT OF TRANSIT DISTRICT

DISTRICT SELLS BONDS OR BORROWS MONEY FOR CAPITAL AND OPERATING EXPENSES AS AUTHORIZED BY ENABLING LEGISLATION

STEP 5: FUNDING SECURED

TAXES ARE LEVIED ON PROPERTY TO REPAY BONDED INDEBTEDNESS

STEP 6: TAX LEVY

(Source: K. Hart, Reference 41)

3.2.1

TYPES OF SHARED-RIDE TAXI CONTRACTS

Types	Advantages	Problem Areas	Location
Fixed Fee	City knows total cost in advance of signing contract	If based on specified standards for level of service, risks are borne by the private operator With new DRT system, it is difficult to predict demand and therefore costs, ahead of time	
Cost plus Fixed Fee • Fixed Amount • Fixed % of Costs	Reduces level of risk to private operator but reduces the risk-based profit to operator	No incentive for operator to minimize costs If fixed % of costs, operator has incentive to increase cost base on which profit is calculated	Combination in Orange County, California --fixed % fee plus fixed subsidy per passenger as an incentive
Fixed Cost per Unit of Service	Profit is built into fixed cost		
• Operator reimbursed on basis of distance or time	Minimized level of risk to private operator	No incentive to provide efficient service	La Mesa, California Livonia, Michigan
• Operator paid on per passenger basis	Indirect subsidy to user Efficient service incentive for operator	Increased risk to operator as he must always keep minimum number of vehicles and drivers in operation	Huntington Park, California El Cajon, California

(Source: Developed from Reference 100)

(iii) Private Operators. Recent experience suggests that contracting for local private services may be the most cost-effective option. This service makes use of existing vehicles and equipment, while paying lower labor costs than traditional public transit operations. In the case of shared-ride service, operations may be started almost immediately by subsidizing local taxi operators. However, this option has been blocked in some cases by local regulations prohibiting ride-sharing, coupled with pressure from private operators who fear their authority and service jurisdictions are in jeopardy.

The facing exhibit shows the types of legal arrangements currently used. The most common type of contract for demand-responsive services allows for a fixed cost per unit of service. Incentive contracts with private operators may be used to encourage more economical service.

Contracting with a private firm for both technical management and operation also appears to be an attractive alternative, as it releases the sponsoring agency from technical problems as well as the subsequent daily management and operating headaches. Nevertheless, the sponsoring agency will still be held accountable to the community, regardless of who is actually performing the services. Direct community and staff participation throughout each step of the design process is therefore advised. Assign a planning staff member responsibility for monitoring and controlling all of the contracted functions to ensure that they are carried out according to the signed agreements and to the community's satisfaction.

The possibility of terminating service should be considered; it may prove easier to break a contract with a private operator than to face firing public employees.

(iv) Special Considerations for Integrated Services. The local agency or operator sponsoring or contracting for integrated service may encounter additional problems. Experience with the use of demand-responsive service to feed line-haul transit is too limited to dictate whether the feeder service should be operated by a public agency, transit authority, or private operator (taxi company). For examples of line-haul and paratransit integration under one transit operator, see System Sheets for Rochester, New York (#81), Ann Arbor,- Michigan (#80), Regina (#128) and Petersborough (129), Canada and St. Bernard Parish, Louisiana (#67).

Integration may require coordinating a variety of management and service functions under one or several operators to connect paratransit with line-haul transit service. This opens up mixed operation and brokerage possibilities. When considering an integrated system, examine the:

- Demand;
- Cost of contracting for service rather than an in-house operation;
- Comparative savings from reduced fixed-route service versus administrative implementation costs;
- Effect on other bus or taxi companies and their regular customers; and
- Possible objections from labor unions.

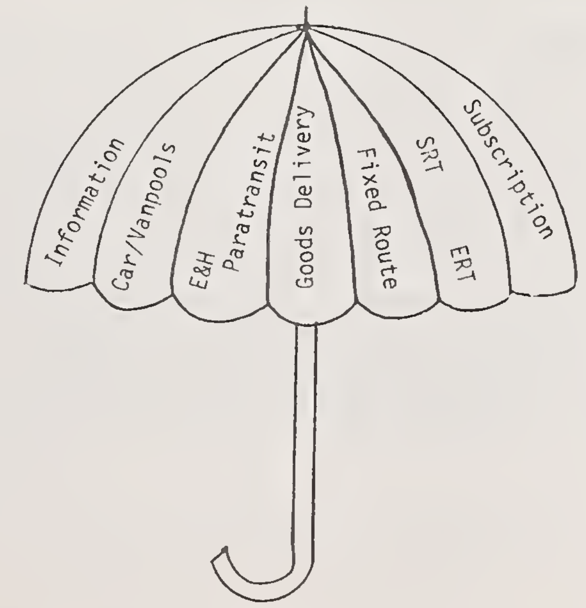
Go to A-4

Line-Haul, Paratransit Integration, see Systems #67, #80, #81, #128, #129

(v) Creating New Options to Fill a Need. If an organizational structure is not currently available which meets or can be adapted to meet the system's anticipated needs, explore the potential for creating a new organization to provide:

- A Family of Services. Westport, Connecticut created a new "umbrella" transit district to provide exclusive and shared-ride taxi, subscription and fixed-route service, supplemented by goods delivery and elderly/handicapped transit activities. This integrated system gains maximum efficiency through the use of a single dispatching center for all services, and also supports brokerage functions, such as carpool and van pool matching and informational and technical assistance services.

FAMILY OF SERVICES



(Source: SYSTAN)

3.2.1

o Brokerage. The brokerage concept was originally created as a new city government department in Knoxville, Tennessee; the facing exhibit outlines the steps used by Knoxville in setting up its brokerage organization to:

- Bring together providers and potential users of transportation services;

- Identify and match needs, rather than promote a single option or mode;

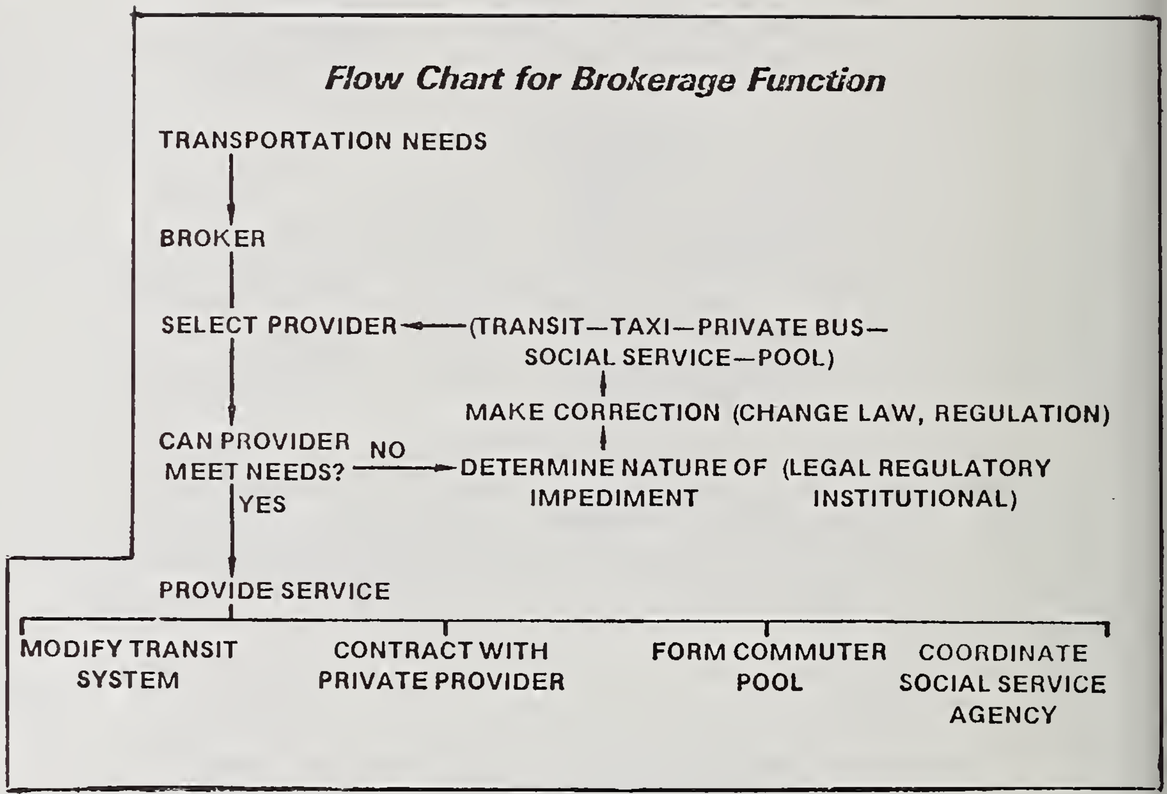
- Provide advice, information and technical assistance (e.g., costs, operation);

- Promote regulatory and institutional change when needed to facilitate ride-sharing. Insurance costs were a major problem; the broker devised a new rating structure for private ride-sharing (vehicles with 15 passengers or less) to free the system from common carrier status and Public Utilities Commission (PUC) regulations;

- Market transit services; and

- Lease vans to individuals for ride-sharing.

The Knoxville experience suggests phasing the development of broker services; only a public commuter vanpool and express bus service were initially available while further studies were undertaken to determine the social service and private sector expansion potential. Although Knoxville appears satisfied with its current brokerage services, other communities should be cautioned to proceed with care, the brokerage concept is still experimental, and further testing and evaluation is recommended.



(Source: TSC Slide Presentation)

To supplement this discussion, the exhibit below outlines the practical experience gathered thus far for public agency, transit authority, private operator, management firm, and non-profit organization options.

The non-profit option is discussed in more detail in the section on target markets, System Characteristics Section 4.2.2. When applying these general guidelines, remember that these factors may vary depending upon the individual operator selected.

GUIDELINES FOR OPERATOR SELECTION

	Local Public Agency	Public Transit Authority	Existing Private Operator	Experienced Management Firms	Non-Profit Organizations
Cost (Labor)	More costly than private but less than public transit authority	Most costly (union labor); may resist competitive service	Least costly; non-union bus usually more costly than taxi but 1/2-3/4 less than public transit authority	Costs vary but are typically similar to non-union private bus operators	Varies; potentially least costly due to charitable contributions & volunteers; least reliable
Implementation Ease	Longer and more difficult implementation as personnel need to be located, hired and trained. New capital investment also required for vehicles and equipment.	Quick and easiest implementation using established authority whose personnel and capital commitment exist; if no existing authority, has longest implementation period.	Fairly rapid and easy implementation using existing entity, where skilled staff and capital commitment exist.	Moderately easy implementation using experienced firm with skilled staff.	Faster than public agency implementation, yet probably most difficult.
Funds	Directly eligible for a wide variety of federal and state funds.	Directly eligible for many federal and state funds.	Ineligible for many federal and state funds; subsidies must be funneled through public body.	Ineligible for many federal and state funds; subsidies must be funneled through public body.	Ineligible for many federal and state funds unless publicly-owned.
Control	Greatest degree of public control.	Moderate to high amount of public control.	Least degree of public control.	Moderate to small degree of public control.	Moderate degree of public control.
Market	Can operate target and/or general market service; probably best suited for total population.	Best suited for general market; difficult to tailor service for all target market needs.	Provides economical travel to target market; expensive to subsidize for general population. Difficult for severely disabled to use taxis.	Can operate service to meet target and/or general market needs; constrained only by public sponsor.	Best suited for specialized segments of population; not suited for general market demands.

(Source: SYSTAN)

3.2.2 Advance Surveys

(A) Uses of Advance Surveys

Advance data collection in the form of surveys can be a costly and time-consuming exercise. "Whereas a good data base is extremely valuable to the design and evaluation of a paratransit system, poorly organized surveys often yield inadequate, erroneous and misleading information" (Canadian Manual, Reference 4). In designing paratransit systems, advance surveys are typically used to:

- Quantify temporal and spatial travel patterns;
- Identify gaps in current transit service;
- Sample public attitudes;
- Predict system demand;
- Demonstrate community support;
- Segment the market for promotional purposes;
- Publicize the system; and
- Develop an evaluation base.

Many of these functions can be met just as effectively without incurring the cost of an extensive advance survey. In some instances, moreover, reliance on advance surveys can be misleading. Advance surveys have proven to be notoriously poor indicators of gross dial-a-ride ridership levels, as many interviewees' theortical commitment to a hypothetical system vanishes when the system is in place and awaiting riders.

This is not to say that all advance surveys should be avoided or that surveys have no place in paratransit analysis. Advance surveys may be the only means of identifying the travel needs and locations of a target population such as the handicapped. Once any system is implemented, moreover, rider attitudes and demand patterns may be assessed periodically through the use of relatively inexpensive on-board surveys. These types of surveys are discussed in more detail in the sections on Implementation (Section 4) and Evaluation (Section 5). In view of the expense that can be involved in conducting an extensive advance survey, and the pitfalls facing the analyst who attempts to use these data for demand prediction, the need for advance surveys must be carefully weighed in the light of their cost, reliability, and alternative courses of action.

I 4.2.7 Data Management Needs

E 6.2.8 Measurement Instruments

(B) Is an Advance Survey Necessary?

In deciding whether or not to undertake an advance survey, the designer should:

(i) List and assess potential survey objectives.

(ii) Identify alternative means of accomplishing these objectives. In the case of the survey uses listed in Section A above, alternative approaches are available for achieving many of the objectives commonly cited for advance surveys. The accompanying exhibit summarizes a few such alternatives.

(iii) Coordinate with demand-estimating procedures. Any advance data collection activities should be coordinated with the process of developing detailed demand estimates (see Section 3.2.7) so that the data collected will fit the selected approach to demand estimation. To date, there is no evidence that demand models requiring massive amounts of specially-collected data perform any better than simpler models using readily-available information.

(iv) Weigh survey costs against the cost of implementation and operation.

(v) Consider the relative flexibility of the system. In a small, flexible system, demand patterns may be serviced as they emerge, so that advance knowledge of precise patterns may be unnecessary.

D 3.2.7 Detailed Demand Estimates

ADVANCE SURVEY USE	ALTERNATIVE INFORMATION	COMMENTS
1. Quantify temporal and spatial travel patterns	- Census journey-to-work statistics - Past O/D studies - Current transit ridership records - Approximation using gravity model and existing demographic data	Existing data may be adequate for identifying general travel patterns and major clusters of trip origins and destinations; however, it is seldom adequate for tracing the movement of target market groups.
2. Identify gaps in current transit service	- Existing transit service maps and records	
3. Sample public attitudes	- Public meetings - Ad hoc newspaper polls - Findings from surveys in other communities - Phone center	General attitudes toward transit have been well documented in several studies and are sometimes transferable. For example, GM research found that the most important system attributes are (a) arriving when planned, (b) having a seat, and (c) avoiding transfers (References 79 and 80).
4. Predict system demand	- Simpler approaches using readily available demographic data (see Section 3.2.7) - In small, flexible systems, learn by doing. Provide the service and adjust to fit developing demand.	Direct use of survey results in demand prediction can be disastrous, as respondents typically promise far more rides than they actually deliver. More elaborate demand models requiring survey data have not proven to be any more accurate than simpler models with modest data requirements (see SCRAPS, Section 5).
5. Demonstrate community support	- Public meetings - Ad hoc newspaper polls	Because advance surveys typically show a higher level of public support for the idea of paratransit than is ultimately reflected in ridership levels when the public is confronted with the fact of paratransit, the positive results of such surveys sometimes provide persuasive political arguments for system implementation.
6. Market segmentation	- Census data	
7. Project promotion	- Media campaigns (see Section 3.2.14)	The promotional value of an extensive survey is often overlooked. Existing systems have reported isolated ridership spurts in areas in which survey teams have been operating (Reference 79)
8. Develop evaluation base	- Current transit ridership records - Surveys taken during the project	Advance surveys are typically needed for evaluation if pre-project attitudes need to be documented , if other perishable data needs to be collected, or if before-after measurements are needed for the non-user population.

(Source: SYSTAN)

(C) Existing Experience

Few existing general market systems have undertaken areawide surveys in advance of system implementation. Exceptions are the Canadian systems in Regina and Charlottetown (References 69 and 79). Samples of the questionnaires used in these cities are shown at the right. These questionnaires were distributed by mail and drop-off and elicited response rates ranging from 10% to 20% of all surveys distributed.

Advance surveys are more commonly used in designing target market systems. In such instances, it is sometimes difficult to identify the travel needs of the target population without a survey, as these needs can be quite different from those of the general population. Moreover, the operation of a target market system may require that rider eligibility be determined prior to use, necessitating some form of advance registration and user clearance. Ideally, this registration process can be used to identify the transportation needs of potential riders.

Surveys designed to determine the travel needs of such target groups as the elderly and handicapped can be distributed efficiently through senior citizen centers and social service agencies. More information concerning the development of advance surveys for target market populations may be found in Section 4.2.5 of System Characteristics.

4.2.5(C)
Information on Target
Market Surveys

Our Family Would Use
"Dial-a-Bus" as follows:

☐ To Elementary Schools: No. of persons

☐ To high schools:

No. of persons to 8:30 classes

No. of persons to 9:00 classes

☐ To University: No. of persons

☐ Shopping at Regent Park Plaza on:

☐ Tues. ☐ Wed. ☐ Thur. ☐ Fri. ☐ Sat.

☐ Downtown Shopping Trips:

☐ Tues. ☐ Wed. ☐ Thur. ☐ Fri. ☐ Sat.

☐ Commuting to work: No. of Adults
(Gov't Buildings & Downtown)

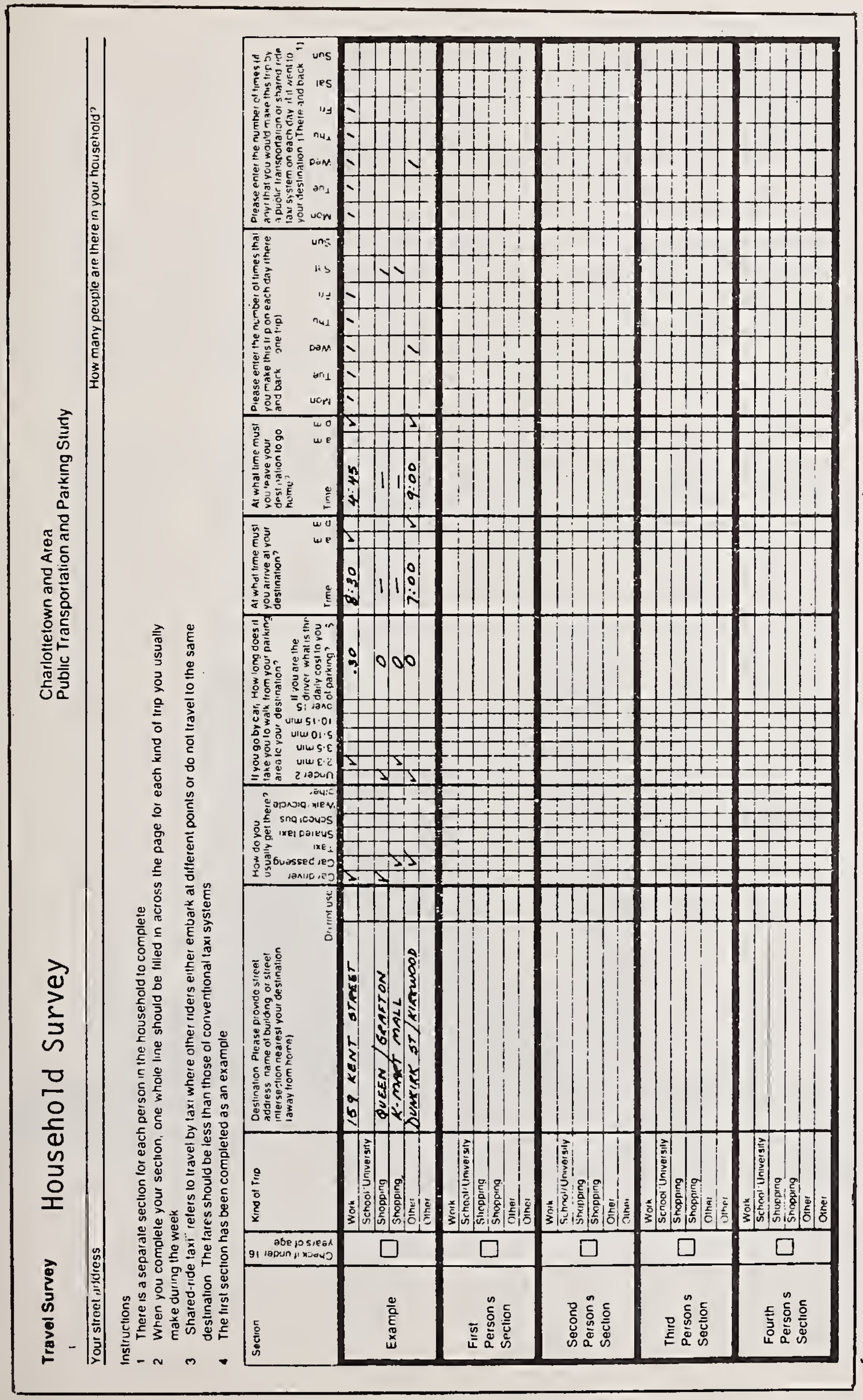
No. of Automobiles in household

Residence Address
or Block No. ______________________

Comments ______________________

____

(Source: Regina Feasibility Study, Reference 79)


Travel Survey

Household Survey

Charlottetown and Area
Public Transportation and Parking Study

Your street address

How many people are there in your household?

Instructions
1 There is a separate section for each person in the household to complete
2 When you complete your section, one whole line should be filled in across the page for each kind of trip you usually make during the week
3 "Shared-ride taxi" refers to travel by taxi where other riders either embark at different points or do not travel to the same destination. The fares should be less than those of conventional taxi systems
4 The first section has been completed as an example

Section	Check if under 16 years of age	Kind of Trip	Destination: Please provide street address, name of building or street intersection nearest your destination (away from home)	How do you usually get there? (Car driver / Car passenger / Taxi / Shared taxi / School bus / Walk, bicycle / Other)	If you go by car, how long does it take you to walk from your parking area to your destination? (Under 2 / 2-3 min / 3-5 min / 5-10 min / 10-15 min / over 15) If you are the driver, what is the daily cost to you of parking? $	At what time must you arrive at your destination? Time (a.m. / p.m.)	At what time must you leave your destination to go home? Time (a.m. / p.m.)	Please enter the number of times that you make this trip on each day (there and back = one trip) Mon Tue Wed Thu Fri Sat Sun	Please enter the number of times (if any) that you would make this trip by a public transportation or shared ride taxi system on each day (if it went to your destination) (There and back = 1) Mon Tue Wed Thu Fri Sat Sun
Example	☐	Work	159 KENT STREET	✓	✓ .30	8:30 ✓	4:45 ✓	/ / / / /	/ / / / /
		School/University							
		Shopping	QUEEN / GRAFTON	✓	✓ 0	—	—	/	
		Shopping	K-MART MALL	✓	✓ 0	—	—	/	
		Other	DUNKIRK ST / KIRKWOOD	✓	✓ 0	7:00 ✓	9:00 ✓	/	/
		Other							
First Person's Section	☐	Work							
		School/University							
		Shopping							
		Shopping							
		Other							
		Other							
Second Person's Section	☐	Work							
		School/University							
		Shopping							
		Shopping							
		Other							
		Other							
Third Person's Section	☐	Work							
		School/University							
		Shopping							
		Shopping							
		Other							
		Other							
Fourth Person's Section	☐	Work							
		School/University							
		Shopping							
		Shopping							
		Other							
		Other							

(Source: Charlottetown Feasibility Study, Reference 69)

(D) Survey Design

As much advance planning as possible should go into the design, administration, and analysis of any survey to be administered in creating a demand-responsive system. Major considerations in this planning process are listed below.

(i) Anticipate results. A thorough analysis should be undertaken to identify the type of information required from the survey, to stipulate the end use of information, and to visualize the form in which the information will be presented. Hypothetical tables and illustrations can be constructed to demonstrate the presentation format. Sample results from past surveys are shown on next page.

(ii) Coordinate advance survey design with evaluation plans. Early in the design stage, evaluation criteria should be specified and work should begin on the development of a detailed evaluation plan (see Evaluation Section). To avoid duplication of effort, and to ensure that variable measurements, sample sizes and target populations are consistent with the overall evaluation plan, all anticipated survey efforts should be coordinated before the first questionnaire is designed.

(iii) Select an appropriate survey methodology on the basis of available budget and anticipated uses. The major methodologies are summarized briefly below, arranged in approximate order of decreasing cost.

- Home Interviews: Households are selected at random from the projected service area. Occupants are then questioned in detail about their trips. This approach usually ensures a high percentage of complete responses, and misunder-

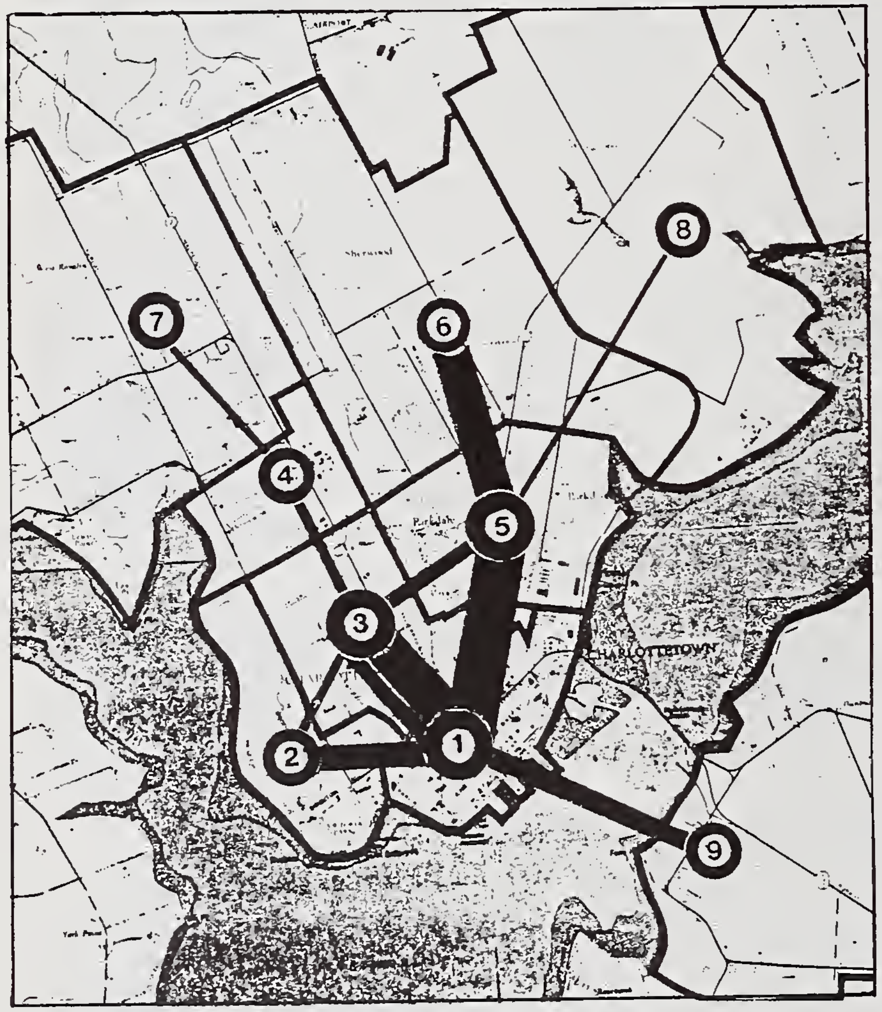
E 6.2 Evaluation Plan

3.2.2

TRAVEL PATTERNS- WEEKDAY MORNING PEAK

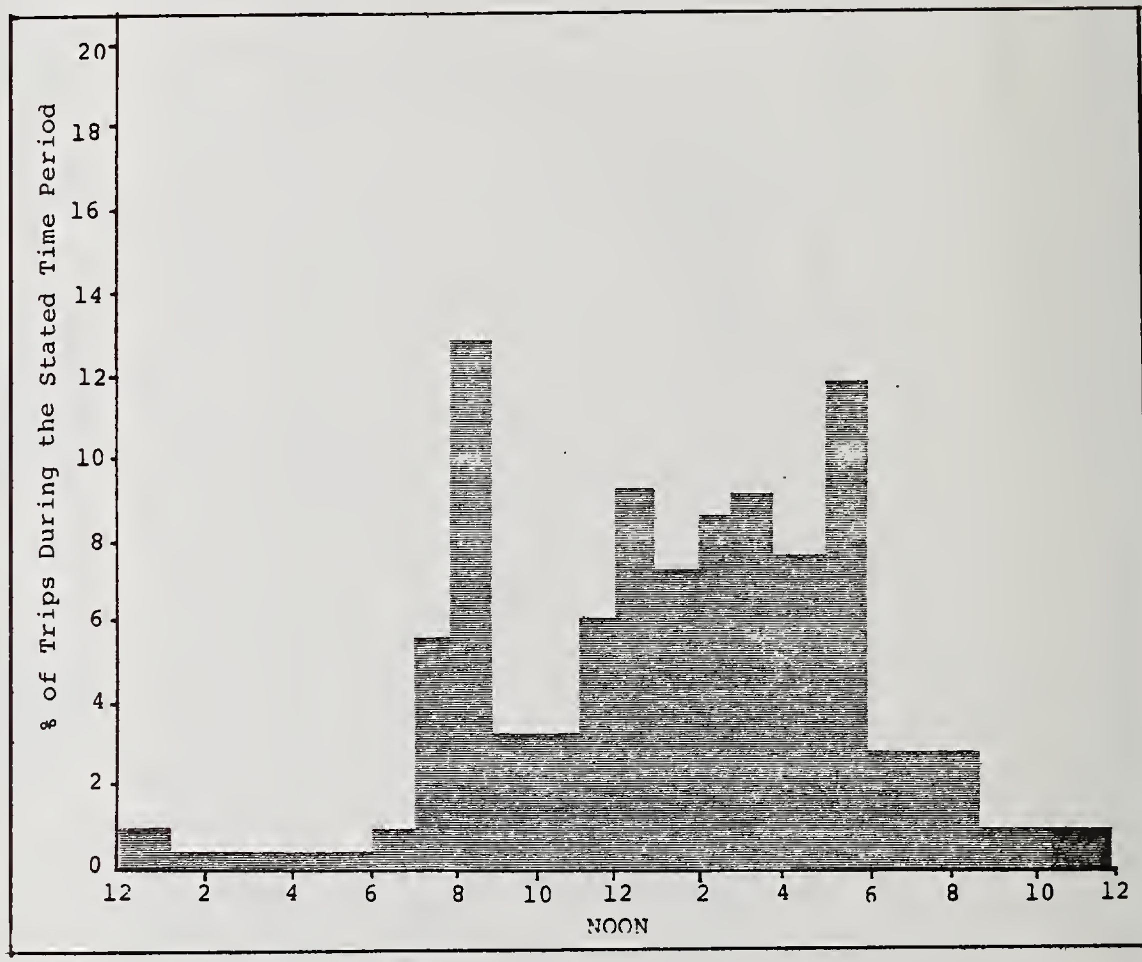
(7 a.m. to 9 a.m.) TWO-WAY

Line width is proportional to the volume of trips made between the indicated zones.



(Source: Charlottetown Feasibility Study, Reference 69)

WEEKDAY TRIP DISTRIBUTION



(Source: Charlottetown Feasibility Study, Reference 69) standings are minimized by the presence of the interviewer. However, home interviews are both costly and time-consuming (Reference 4 estimates their cost at between $10 and $20 per household).

- On-Site Interviews. Interviewers focus on subjects selected at random at activity centers or places of employment. The personal interview approach is similar to that employed in home interviews, with the resulting investment of time and money.

- Telephone Interviews. These are less costly than home interviews and offer comparable efficiency, except where attitudinal questions are asked. They cost $2.00-$5.00 (Reference 4) for an interview and analysis, and are usually performed by trained personnel who interview respondents over the telephone in the evening.

- Mail Questionnaires. Questionnaires are mailed to a pre-selected random sample of service area residents. This approach is relatively cheap ($1.00-$3.00 per household--Reference 4), but it is difficult to ensure a high response rate. The Canadian Dial-A-Bus Manual (Reference 4) observes that "If appropriate advance publicity has been given and if the public is receptive, the postal survey can be very effective."

- Drop-Off Questionnaire. Questionnaires are distributed at key activity centers. This approach is particularly effective in surveying target markets such as the elderly, where distribution points include senior housing, churches, social service agencies, medical centers, senior citizen centers, etc. As with the mail approach, the questionnaire is self-administered and the response rate may be low.

- On-Board Surveys. Questionnaires are distributed to transit riders as they board the vehicle. The questionnaire may be completed during the ride and returned upon leaving the vehicle, or completed at leisure and mailed in. The sample population is limited to existing transit users, a drawback in some applications.

- Ad Hoc Newspaper Polls. One of the cheapest means of conducting a survey is to persuade a local newspaper to publish a brief questionnaire, or to purchase advertising space for the purpose of questionnaire distribution. Questionnaires distributed in this fashion should be concise, and the analyst loses the ability to select or even to identify the sample population adequately.

In planning, designing, and evaluating demand-responsive systems, advance surveys are usually mailed or dropped off at key activity centers, while on-board surveys are used for monitoring and evaluation.

(iv) Develop sampling plan. The proportion of the sample population surveyed will depend on a number of factors, including the level of accuracy desired, the size and homogeneity of the total population, the analytic technique used, and the available budget (see Reference 56). Home interviews generally should be administered by trained personnel, and specialists should ordinarily be consulted before undertaking costly and elaborate surveys.

Since demand-responsive systems are relatively flexible, pinpoint accuracy is seldom required in surveys conducted for design purposes. Most of the simpler surveys (e.g., mail and drop-off surveys) can be undertaken using local personnel. Social service agencies and senior citizen centers can often assist with surveys of target market populations.

In the case of services designed for the elderly, a rough rule of thumb is that for areas of under 50,000 population (approximately 5,000 elderly), a satisfactory sample size is about 20% of the target group (Reference 56). This is consistent with a rule of thumb that states that, for the worst statistical case, a sample of 400 from large populations provides less than $\pm 5\%$ sampling error on multiple-choice questions. If the population is to be divided for analysis purposes, a large sample is desirable.

<u>(v) Develop analytical plan</u>. Plans for analyzing survey data should be made in advance of the survey. If models are to be used for forecasting ridership or extrapolating survey results, the survey data should fit the format of the model and the sampling plan should not violate the assumptions of the analytic models.

<u>(vi) Construct questionnaire</u>. Surveys taken in advance of system implementation should attempt to elicit a variety of information from the respondents, including:

1. Frequency of travel (trips per day, per week, per month)
2. Purpose of travel
3. Origins and destinations of travel
4. Time of travel (time of day)
5. Current transportation mode
6. Satisfaction with current mode
7. If additional transportation (i.e., paratransit) were available, where else would the respondent travel?
8. Demographic characteristics (e.g., age, sex)

In the case of target market groups, additional questions may be asked to gauge the nature of any infirmities and to ensure that the respondent qualifies for a restricted service.

Sample survey forms from a variety of systems are included in Appendix 10.

<u>(vii) Pre-test questionnaire</u>. All questionnaires should be pre-tested on a limited sample of respondents before distributing them to the target population.

Go to A-10
Sample Survey Forms

3.2.3 Specify Service Boundaries

Boundary specification is a key item of design that may determine the success or failure of the new service. The general approach followed in boundary setting is to select the area in which the service is most likely to succeed. It is always possible to expand boundaries to encompass new users. Contracting boundaries is much more difficult because some patrons need to be abandoned.

The boundary design process, designed to define the area and patronage of the service, is divided into four steps:

(A) Familiarization;
(B) Review demand;
(C) Set tentative boundaries; and
(D) Test boundaries.

(A) Familiarization

During the planning phase, it was satisfactory to select boundaries from maps, arterial photographs and other existing sources. For the design stage, the site should be systematically examined, block by block, for major developments:

- o High-density residential
  - Apartments/condominiums
  - Townhouses/cluster housing
- o Commercial
  - Strip
  - Occasional
  - Shopping centers
- o Health care
  - Hospitals
  - Nursing homes
  - Professional offices
- o Public service
  - Social welfare
  - Local government
  - Other
- o Industrial
  - Large plants
  - Small and medium plants
- o Recreational
- o Schools

Select several high-density residential units. Interview the managers to learn the characteristics of the residents (age, family size, income, types of activities, facilities within the complex, etc.). Interview store and shopping center managers to learn something of their customers: where they live, how much they buy, how many shop per day and at what times, etc. Also ask about the manager's interest in the new service. He may be willing to promote it or support it. Interview health care facilities to ascertain the kinds of service available, the types of patients and visitors, when visiting hours are, where employees live, etc. Similar information should be obtained from public service, industrial, recreational and school facilities. Many employers will locate their employees by neighborhood or zone, but few will give actual addresses.

3.2.3

If checkpoints are included in the plan, visit each proposed checkpoint and alternative checkpoints. Examine facilities for vehicle stopping, vehicle queues if appropriate, passenger waiting and passenger access locations. Pay particular attention to passenger safety. Check other key locations for easy exit and entry. Remember, vehicles cannot enter private property (e.g., parking lots) without the consent of the owner!

Check corners, intersections and traffic to be sure that vehicles can maneuver effectively at the site. It is also useful to make a series of random trips at different times of day to estimate vehicle speeds.

Reduce all data and notes for careful recording on a small set of maps.

(B) Review Demand

The purpose of the demand review is to test the expected uniformity of demand when applying the guidelines of Section 2.2.10 to the site characteristics identified. Special attention should be paid to the appearance of very high and very low demand areas. These areas should be noted.

If the new service will be coordinated with existing services, the data from Section 2.2. 3 will be helpful in identifying service and schedule requirements (keeping other service demands in mind).

(C) Set Tentative Boundaries

Enough data are now available to support the setting of tentative boundaries. This is a manual, trial-and-error process to tax your skill and ingenuity! (Avoid the

BOUNDARY CONSIDERATIONS

- Topographical and jurisdictional features to consider in determining the boundaries of a potential integrated paratransit service area include:
  - City or town political boundaries
  - Traffic zones
  - Census tracts
  - Rivers or other terrain features
  - Major highways and arterials
  - Rail lines
  - Neighborhood identity
- Traffic features to consider include:
  - Number and location of activity centers and trip generators
  - Location of connecting fixed-route transit stops
  - Relative percentage of trips beginning and ending within the service area
  - The existence of comparable and continuous travel zones
- It is useful to remember that boundaries need not be impermeable barriers. It often proves desirable to designate an activity center just outside the nominal boundary lines as a permissible pick-up and drop-off point. In this way, the number of desirable trip attractors served by a system can be increased without increasing the service area beyond appropriate bounds or imposing the need for transfers on service patrons.
- It is a common feeling among practitioners that service area boundaries are determined by budget, citizen input, political process and travel patterns rather than by political boundaries; thus, city systems may not in fact provide full coverage to the city.

(Source: SYSTAN)

2.2.3 Inventory of Existing Systems
2.2.10 Estimation of Supply and Demand

temptation to extend service area size beyond its capacity.) Pay particular attention to the size guidelines of Section 2.2.6. These are approximate, but they may help to keep service area size down. Try following the procedure outlined in the exhibit when setting service area boundaries.

(D) Test Boundary

The selected boundary should be carefully tested before it is adopted. First, a brief report describing the selection process should be prepared and distributed to:

- Planners;
- Citizen organizations;
- Traffic engineers;
- Taxi operators;
- Transit operators;
- Business associations; and
- Public officials.

Every effort should be made to hear whatever comments and criticisms are available. All comments and criticisms should be reviewed in the design process. If they are minor, only minor adjustments may be needed in the boundaries. If they are significant, a new boundary should be prepared based on both new and old data, and a new report should be prepared and circulated. When a concensus is reached on the boundaries, it may be appropriate to call a public meeting(s) to present the results.

SUGGESTED STEPS FOR DEFINING SERVICE AREA

1. Take a clean map or overlay, lay it over the data map.
2. Mark all major topographical barriers (e.g., rivers, railroads, freeways).
3. Mark homogenous residential neighborhoods.
4. Mark principal commercial, health care, public service, industrial, recreational and educational centers.
5. Draw the smallest boundary that incorporates enough residential population and enough activity centers to contain sufficient interzonal trips to make up one-third of the estimated demand. Recognize topographical boundaries.
6. Examine the area adjacent to the minimum zone. Add isolated neighborhoods and activity centers. Add activity centers adjacent to the boundary.
7. Make a few test runs to the far reaches of the defined area to make sure that a bus can tour the area in a reasonable time without inconveniencing other passengers.
8. Draw the proposed boundary and submit it for review.

(Source: SYSTAN)

P 2.2.6
Candidate Sites

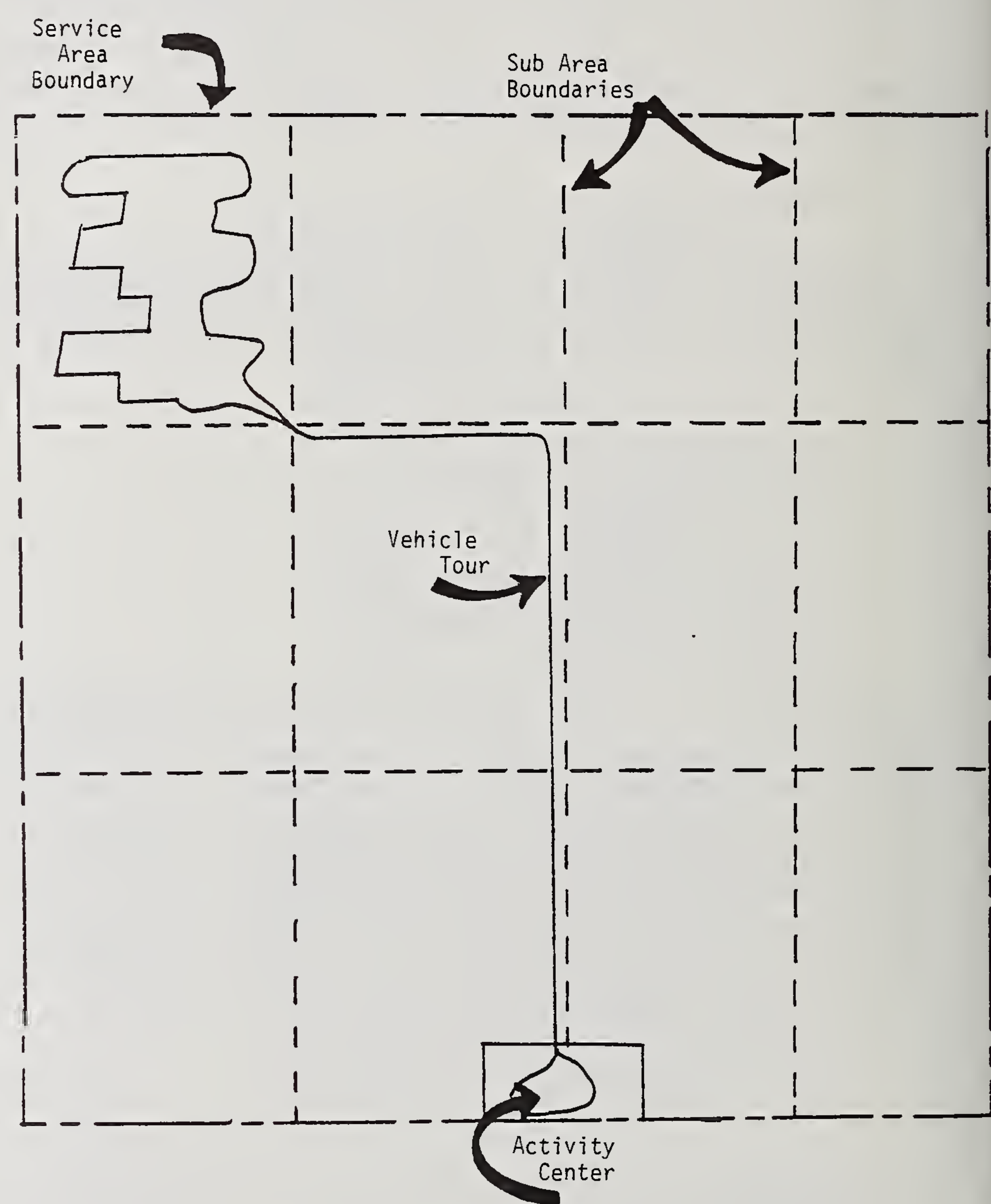
3.2.4 Tour Design and Coordination

The basic unit of operation of a demand-responsive system is the round-trip bus tour from a starting point (which may be chosen arbitrarily), through the service area (where passengers are picked up and dropped off), and back to the vicinity of the starting point. Because of the dynamic nature of demand-responsive service, tours are rarely identical from one day to the next, and cannot be explicitly defined. Basic tour patterns can also be expected to vary during the peak, midday and evening hours of operation.

The details of the tour are developed from the ridership characteristics of the area served, the geometrics and terrain of the area, the need to connect with other bus routes, the performance of the bus in transit, and passengers alighting or boarding. The task of optimizing tour parameters thus becomes a process of meeting some criteria exactly (e.g., connecting bus headways), minimizing others (e.g., on-route congestion delays), maximizing others (e.g., potential numbers on board), exercising experienced judgment (e.g., how much terminal layover time is appropriate), and trading off conflicting objectives (Reference 4).

A vehicle tour may or may not include an entire service area. The service area may be divided into sub-areas, as shown in the diagram, with one or more vehicles assigned to each sub-area. In this case, a vehicle tour consists of a line-haul segment that connects the service area's activity center with the demand-responsive circuit of the designated sub-area.

SUBDIVIDED SERVICE AREA



(Source: SYSTAN)

(A) Route Layout

The first element in tour design is to select the foci: activity centers and checkpoints as appropriate. These can be nominated from the information developed in the boundary investigation. Remember, for many-to-one service, there must be one destination that completely dominates the activity of the service area. Many-to-few is a more common tour configuration.

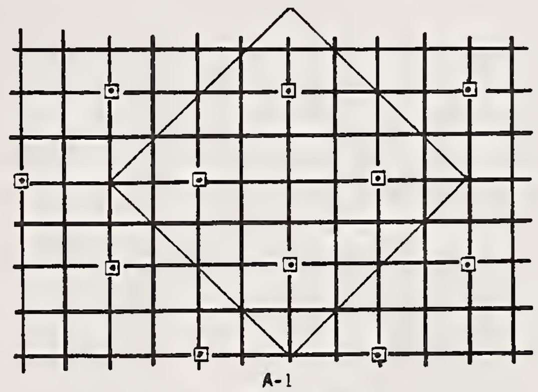
A checkpoint for non-doorstop service should be within walking distance from any point in the area served. This generally means that for optional area coverage, a rectangular pattern of checkpoints works best. Checkpoints are normally located on main or arterial streets for easy vehicle access. A series of checkpoints along an arterial street can be efficiently covered even when deviation is offered between checkpoints.

The spatial relationships among checkpoints is important (see facing exhibit). Both of the checkpoint configurations shown here are based on a rectangular street pattern, and both require passengers to walk a maximum of three blocks. The staggered checkpoint configuration (A-1) allows four checkpoints to serve an area of 72 square blocks (18 square blocks per checkpoint). In sharp contrast, the regular configuration (A-2) allows vehicles to operate along arterial streets in a rectangular pattern, but it requires nine checkpoints to serve 81 square blocks (nine square blocks per checkpoint--only half as efficient).

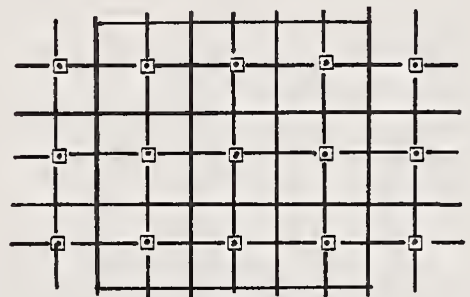
A second consideration is the division of the service area into sub-areas. If the service area is to be served by only one vehicle, then that vehicle must serve the entire area. However, if two or more vehicles are needed to serve the area, some options may be explored:

CHECKPOINT CONFIGURATIONS

(Rectangular Street Network)



A-1
Check Point Optimal
Maximum walk = 3 Blocks
18 sq. Blocks / Checkpoint



A-2
Vehicle Route Optimal
Maximum walk = 3 Blocks
9 sq. Blocks / checkpoint

Both of the checkpoint configurations shown here are based on a rectangular street configuration and both require passengers to walk a maximum of three blocks. The staggered checkpoint configuration (A-1) allows four checkpoints to serve an area of 72 sq. blocks (18 sq. blocks per checkpoint). In sharp contrast, the regular configuration (A-2) allows vehicles to operate along arterial streets in a rectangular pattern, but it requires nine checkpoints to serve 81 sq. blocks (nine sq. blocks per checkpoint -- only half as efficient).

(Source: SYSTAN)

3.2.4

- All vehicles can be assigned to serve the entire area. This means that each vehicle is likely to perform a long tour, but multiple vehicles provide reasonably frequent service.

- Each vehicle could be assigned to a sub-area. Individual tours would be shorter and faster, but a passenger just missing a tour would have to wait for the next tour by the same vehicle. Subdivision is efficient for many-to-one and many-to-few services, but it is not practical for many-to-many service.

- The service area could be divided into sub-areas, with more than one vehicle assigned to each sub-area.

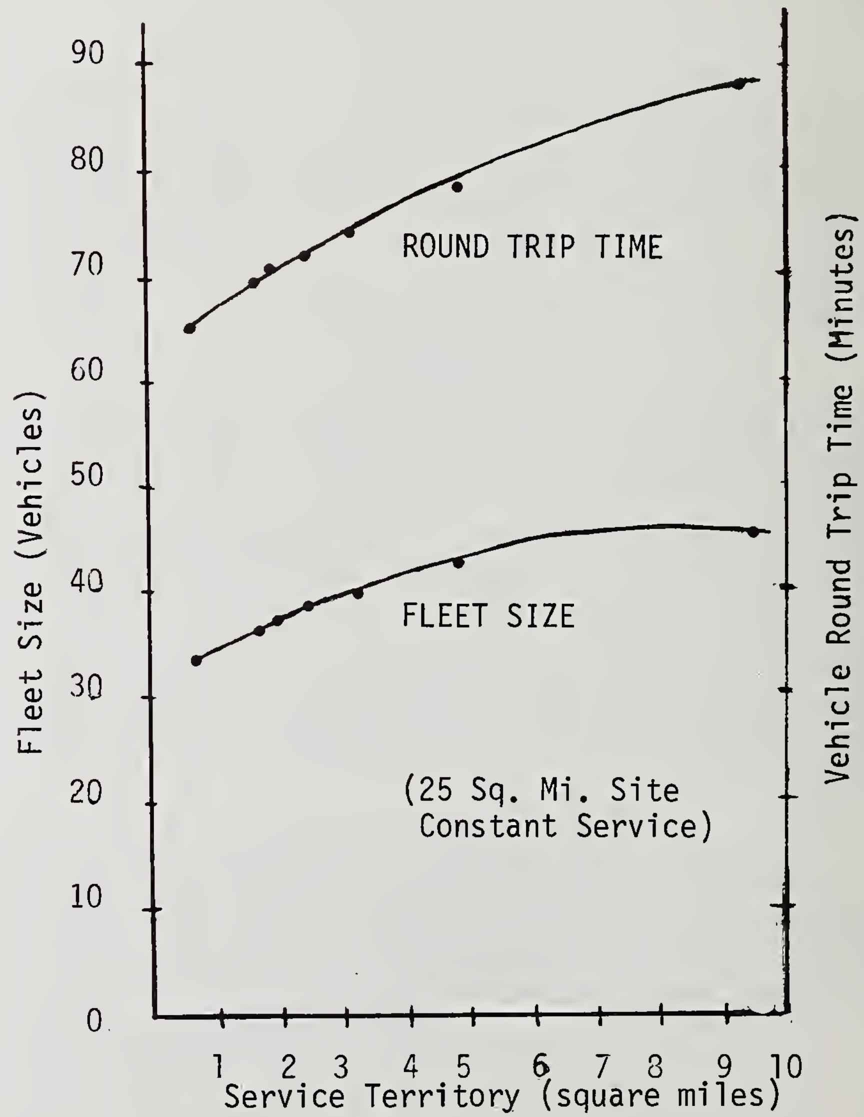
The facing exhibit illustrates the impact of service territory size on round-trip time and fleet size for a 25 square mile site with constant demand. As the service territory increases, round-trip time increases and more vehicles are needed to maintain the level of service. Nonetheless, more frequent service is provided in the larger territories. Thus, for the individual passenger, the choice is between a shorter, more direct trip and more frequent service.

If the service area is to be divided into sub-areas, boundaries must be selected for these sub-areas. The guidance of Section 3.2.3 is useful, with the following modifications:

- Divide the service area into a single business (commercial/industrial/government/recreation) sector and a set of relatively homogeneous

3.2.3
Specifying Service
Boundaries

IMPACT OF SERVICE TERRITORY SIZE ON ROUND TRIP TIME AND FLEET SIZE



(Source: SYSTAN)

residential sectors. The residential sectors should have about equal estimated demand; they need not be of equal size.

- Plan a common tour around the business sector that comes within walking distance of all or most of the business sites.

- Plan line-haul routes between the business tour and individual residential sectors.

- Check residential sectors for easy access to all residential addresses. Provide checkpoints for housing complexes with difficult access.

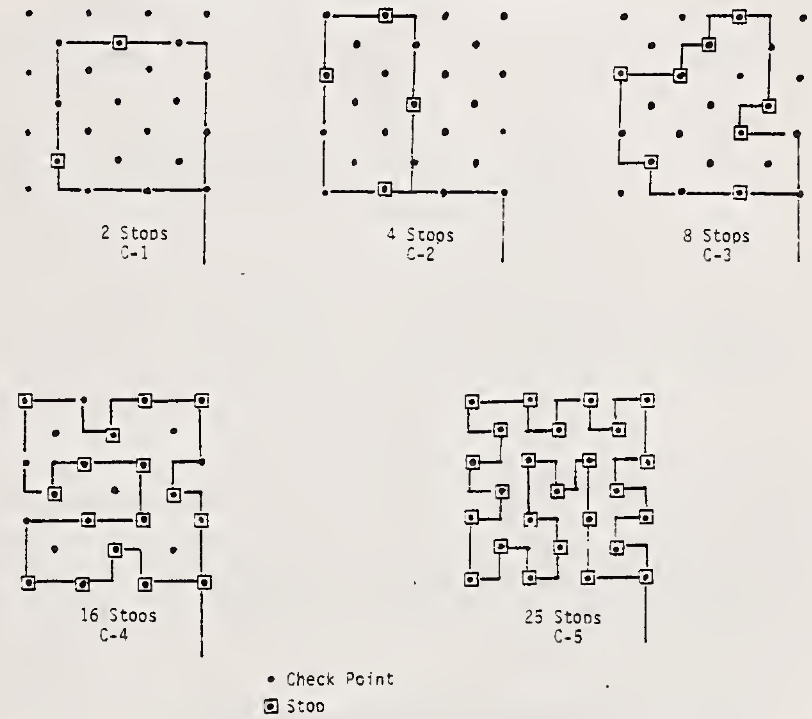
Sub-area boundaries are not as critical as service area boundaries. However, passengers do become accustomed to a particular sequence of service, and they can be upset by change.

Tour guidelines also need to be prepared for checkpoint service. The guidelines should provide an orderly progression for serving blocks of checkpoints so that passengers can be accommodated with minimal travel time and distance. The facing exhibit illustrates one approach for a site with 25 checkpoints. There are several methods to serve all checkpoints having about the same efficiency.

(B) Timing the Tour

Tour times can be calculated, or they can be estimated from timed simulation runs in the service area. The simulation approach, although time-consuming, reflects the realities of existing traffic and traffic controls.

EXAMPLE OF CHECKPOINT SERVICE



The objective is to serve the active checkpoints with as little backtracking as is necessary.

(1) If possible, include all stops in the rectangular route to the farthest checkpoint to be served (see C-1 and C-2).

(2) If all points cannot be served by a singular rectangular route, minimize the amount of backtracking by a succession of stepwire movements (see C-3).

(3) As the number of checkpoints to be served grows, it will be desirable to travel the area more than twice. Do this as efficiently as possible, accommodating the maximum number of checkpoints with each traverse (see C-4 and C-5).

(Source: SYSTAN)

3.2.4

The fundamental tour time relationship is as follows:

TOUR TIME = RUNNING TIME + PASSENGER TIME
+ TERMINAL TIME

Where: tour time = time required for one vehicle tour

running time = time required for all normal safe driving procedures on a projected base route

passenger time = time required for passenger pick-up and drop-off

terminal time = time the bus spends in layover time or time recovery at the tour terminal

Running time depends on the distance traveled and the average speed. Distance, in turn, depends on the number of stops per tour, which is variable. Estimating procedures for different types of demand-responsive services are outlined below:

(i) Base Many-to-Many Service.

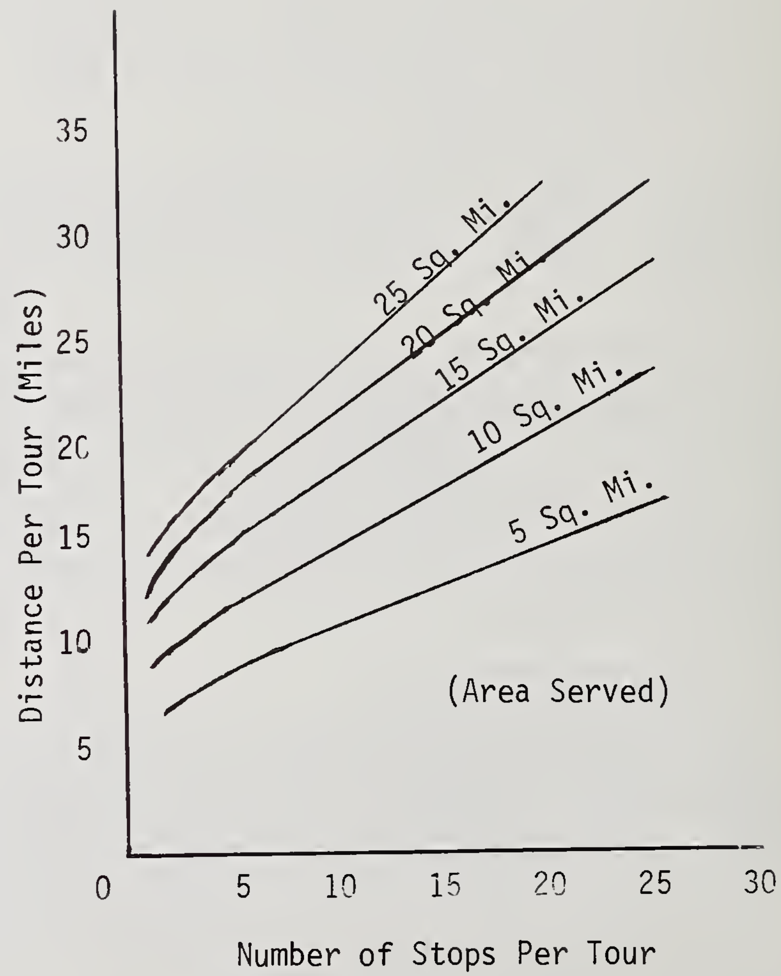
- Estimate a tour time.
- From demand data, determine the number of stops per tour to satisfy the demand:

$$n = \frac{60AsD}{T}$$

Where: n = estimated stops per tour,

As = area of service territory, in square miles,

ESTIMATED TOUR DISTANCE



(Source: SYSTAN)

D = estimated demand (passengers per square mile per hour), and

T = estimated tour time in minutes.

The above expression covers one-way movement into or out of the residential area. One- or two-way movement: n = 120 As D/T

- Estimate the distance driven per tour:

$$d = d_t + d_l + d_b$$

Where: d = distance driven per tour, miles,

d_t = distance driven around residential service territory to pick up and discharge passengers, miles,

$$d_t = \sqrt{A_s}\left\{2.1 + n\left(0.16 + \frac{1}{n+1}\right)\right\}$$

(values plotted in exhibit)

d_l = line-haul distance (both ways) between service territory and business sector, in miles, and

d_b = distance driven around business sector in miles.

Line-haul and business tour distances can be taken from maps.

- Calculate new tour time

$$T = \frac{d_t}{v_t} + \frac{d_l}{v_l} + \frac{d_b}{v_b} + t_p + t_t$$

Where: v_t = mean residential tour speed, mph

v_l = mean line-haul speed, mph

v_b = mean business tour speed, mph

t_p = passenger time

t_t = terminal time

If the new tour time is substantially different from the last estimate, repeat the calculations. Otherwise, use the estimated tour time.

<u>(ii) Many-to-One Service With Fixed-Route Connector</u>. (Source: Reference 4)

- Determine headway of line-haul bus or rapid transit system to be linked with the paratransit system.

- Select an initial "design" tour time for the paratransit system (normally in multiples of the line-haul headway).

- Define the geographical limits of the tour area.

- Estimate the tour time using average demand figures.

- Determine whether the initial "design" tour time can be comfortably met by simulating pick-ups and drop-offs on a random basis, plotting routes to service them, and measuring route mileage.

- If tour time cannot be met, expand by one line-haul headway multiple and try again. Alternatively, more buses can be added to service demand within the same tour time.

(iii) Route Deviation System Layout (Source: Reference 4).

- The following basic equations can be used in layout of a route deviation system:

TOUR TIME = RUNNING TIME + PASSENGER TIME + DEVIATION TIME + TERMINAL TIME or

$$T = LS + N_d T_d + N_s T_s + T_r$$

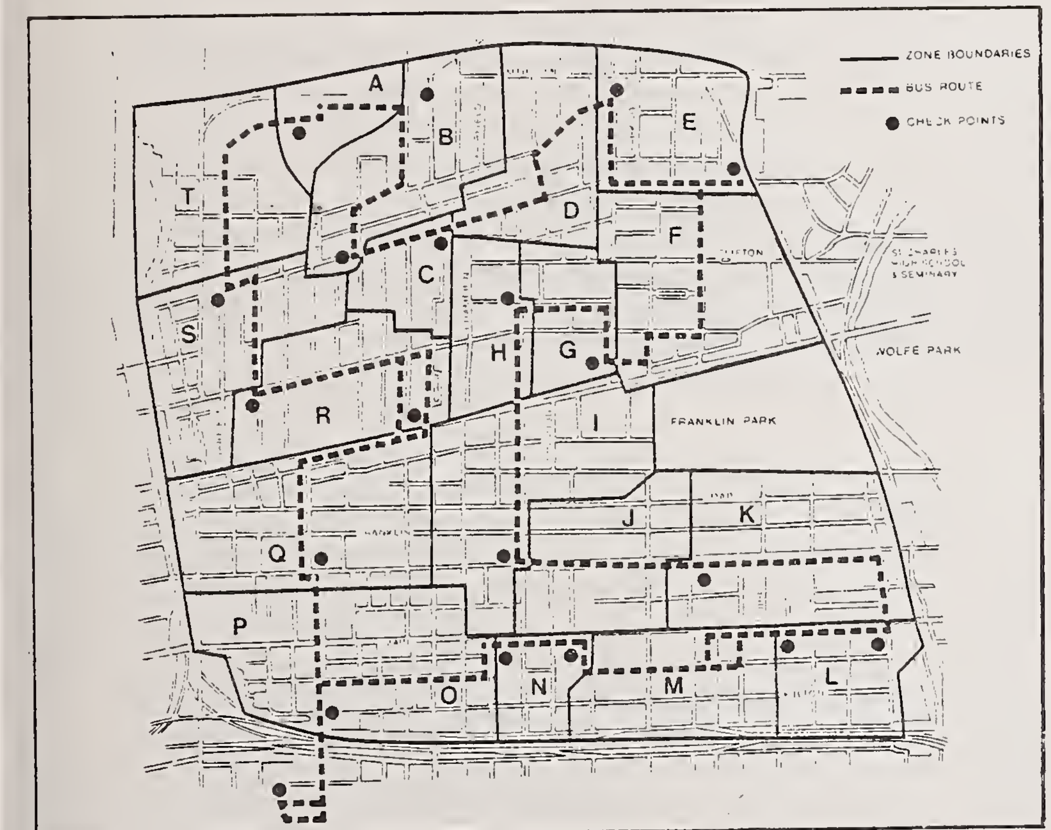
Where, additionally:

LS = Tour length/vehicle speed
N_s = Number of stops for pickups or dropoffs
T_s = An average time for an N_s
N_d = Number of deviations made from route (note that N_d can be expressed as a percentage of N_s)
T_d = An average time addition for an N_d
T_r = Terminal time

- The following general steps are necessary when planning loop-type operations:

  - Define the geographic limits of the service area; establish a loop system for pickups and dropoffs based on the situation of the activity centers, and measure the route length.
  - Divide the area into zones of similar size and locate at least one checkpoint at key intersections in each zone for dispatching purposes. In the Columbus, Ohio system (see facing exhibit), a six square mile service area was divided into 20 zones. Each zone was served by at least one link of the loop and 21 checkpoints were chosen which corresponded to major trip generators or high-use corners.
  - Calculate the loop driving time (excluding pick-up and drop-off delays and deviations).
  - Estimate the average number of pick-ups and drop-offs per hour for the service area.
  - Calculate the total deviation delay time.
  - Calculate the total tour time. This is a function of the number of passengers per tour, deviations, tours per hour, time of day, etc. Thus, the development of operation characteristics for the service becomes an experimental and repetitive process with several variables. Other factors involved are whether buses operate in one or both directions, and their service headways. The effect upon level and quality of service caused by the number and direction of buses is not as simple as it may at first appear, and is additionally a function of the posi-

COLUMBUS, OHIO DAR LOOP SYSTEM



(Source: Canadian Dial-A-Ride Manual, Reference 4)

tion on the tour loop at which the service is being measured. Tables should be constructed of various combinations of values for the variables.

(C) Service Coordination

The service design should include a carefully-conceived coordination plan that includes:

- Services to be coordinated, including brief descriptions, territories, schedules and characteristics of each;
- Trip types requiring coordination, including purpose, time of day, frequency and urgency;
- A precise coordination sequence for each trip type; and
- A specific coordination plan for each sequence.

Demand-responsive services must be scheduled to coordinate with complementary services. Coordination can include demand-responsive feeder service for scheduled, fixed-route transit systems. It can also include the use of demand-responsive vehicles for subscription-type service during the morning and evening peak periods.

Coordination design assures that the proper vehicle and driver are in the right place at the right time. For example, if a many-to-one dial-a-ride service provides feeder service for fixed-route bus, then (insofar as possible) the dial-a-ride vehicles should arrive at the transfer point a few minutes before the fixed-route bus is scheduled to arrive. This coordination is difficult to achieve because:

- Fixed-route buses do not always arrive on schedule; and

- Dial-a-ride tours vary widely in duration, and are not predictable. On the average, one can expect tour times to fit fixed-route bus headway intervals.

The design can improve transfers by designing short tour times or mean tour times that are integral multiples of fixed-route bus headways. There are also ad hoc solutions to these problems that eliminate requirements for long waits at transfer points. Dial-a-ride drivers can ascertain whether they have transfer passengers and, if so, they can modify their tours to meet the bus schedule. This will inconvenience some passengers. Dial-a-ride drivers might also contact the fixed-route bus driver by radio to coordinate a meeting time. These adjustments will alter the service performance of the dial-a-ride system, and should therefore be adopted cautiously.

Transfer requirements may also occur between demand-responsive vehicles serving adjacent sites or adjacent service territories; these also need to be coordinated. If sufficient advance notice is given to drivers, they can often be arranged with little inconvenience.

Multiple-vehicle uses pose a different coordination problem. Demand-responsive vehicle drivers may use their vehicles for subscription commuter service before and after normal service hours. Such an arrangement may be a convenience to drivers, and it may provide them with an additional source of income. It may also create difficulties when attempting to modify the service schedule. Although this form of coordination lies outside the demand-responsive service, the wise designer will allow for it if possible.

(D) Dynamic Adjustment of Zone and Route Structures

Small-scale paratransit services lend themselves to dynamic adjustment in response to experience with demand patterns. Certain small, experimental systems have been launched effectively with minimal planning and design effort, with subsequent routing, scheduling and fleet assignments adjusted in response to demand.

If organizational barriers do not exist, a similar dynamic approach may be applied in integrating conventional fixed-route operations and paratransit operations. After operating the two systems in tandem, non-productive fixed-route elements might be replaced with paratransit operation, while areas in which paratransit demand is unusually heavy might be provided fixed-route service. These dynamic route-rationalization procedures should not ignore the ridership which is displaced when services are introduced or phased out.

3.2.5 Detailed Demand and Fleet Size Estimation

Rough estimates of demand and fleet size were developed in the planning stage. In the design stage, these estimates may be refined and carried to a finer level of detail. Planning estimates may be refined in a number of ways:

(1) Through the use of more sophisticated models;

(2) Through sensitivity analyses using simple planning models; or

(3) By field-testing planning concepts.

In some instances, the additional expense required to use more sophisticated models may not be warranted in the light of the uncertainties inherent in paratransit demand prediction. Most systems, however, will benefit from sensitivity analyses using simple planning models and controlled field-testing.

Whether or not new estimating techniques are introduced in the design process, initial planning estimates should be updated to reflect any changes in assumptions or operating policies introduced by decisionmakers at the end of the planning process. (This was not done in Santa Clara County, when a political decision was made to lower the system fare to 25¢ a ride after demand had been forecast at 50¢ a ride. Failure to recompute demand estimates on the basis of the lower fare was one of the factors contributing to severe underestimates of initial demand and the early swamping of the system.)

(A) Detailed Demand Estimates

In the case of simple one- and two-bus systems, the rough estimates developed in the planning stage will usually be suitable for design work. To date, sophisticated demand models have not performed with sufficient accuracy to justify the time and expense entailed in their application to simple design cases.

<u>(i) Deciding Whether to Make More Detailed Estimates.</u> More detailed demand estimates may be warranted:

- <u>When fairly complex systems are contemplated and large initial investments are at stake.</u> In this case, more detailed modeling can be justified, if only to provide sensitivity analyses that illuminate the effect of poor estimates and bound the likely ranges of demand.

- <u>When a current data base identifying existing travel patterns already exists in an area.</u> Such a data base can usually be employed in refining demand estimates with a minimum investment of time and effort.

<u>(ii) Detailed Demand Models.</u> In recent years, several approaches to paratransit demand prediction have been developed which incorporate more detail on travelers, travel patterns, and system performance than the simpler models used in the planning stage. (See Section 2.2.10). A few of these models are listed below.

- Multisystems and Cambridge Systematics have developed a disaggregate model which balances supply and demand (Reference 172).

P 2.2.10
Demand Estimation

DETOUR

For smaller systems lacking a current data base, detailed demand estimates may be unnecessary; the rough estimates developed in the planning phase should suffice, so long as they are adjusted to reflect any operational changes introduced in the design stage. Proceed to Section 3.2.5(B).

- A.M. Voorhees has developed diversion curves which may be applied to known travel patterns in the traditional approach to demand prediction, which entails the four steps of trip generation, trip distribution, modal split, and assignment (Reference 258).
- DAVE Systems has developed an aggregate model expressing demand in terms of elasticities with respect to fares, service levels, and uncertainty (Reference 93).

The most detailed models available, simulation models, generally do not attempt to predict demand, but instead treat it as an exogenous event. Reference 168 contains a review of the input requirements, output, assumptions, and performance of most existing paratransit demand models.

(iii) Estimating Latent Demand. The introduction of a new transit system will generate a certain demand for travel which had not previously existed. This latent demand, which is likely to be particularly significant in the case of paratransit operations serving the elderly and handicapped, is difficult to estimate in advance of service. In simpler estimating tools, such as the planning models discussed in Section 2.2.10, latent demand is not estimated separately, but is implicitly included in the resulting ridership forecasts. This occurs because the basis for the forecast is ridership on similar systems, which includes latent demand.

If ridership estimates are derived from historical travel patterns in the study area, it is advisable to include an allowance for latent demand not included in his-

ANALYTICAL TOOLS 5.0 for more details on demand models.

P 2.2.10 Demand Models

torical data. Unfortunately, no general tools have been developed to assist in estimating levels of latent demand on paratransit systems. Experience on existing systems is perhaps the best indicator of the likely levels of demand for future services. A Haddonfield, New Jersey survey showed that 12% of the trips made on dial-a-ride would not have been made if the service did not exist. A similar survey in Ann Arbor showed a 20% latent demand. These are both general market systems. Latent demand is likely to represent a higher percentage of the ridership on target market systems. (See System Characteristics, Section 4.2.7).

(B) Detailed Fleet Size Estimates

A detailed specification of the system configuration (Section 3.2.4), coupled with the selection of vehicle types (Section 3.2.8) and the development of more detailed demand estimates (Section 3.2.5(A)) provides the basis for a more informed assessment of the number of vehicles needed to provide the desired service. In the planning stage, fleet size estimates were based on the experience of systems operating in other settings. During the design stage, estimates should be adjusted to reflect the specific setting and service. From a practical standpoint, these revised estimates should reflect:

- Specific vehicle capacity;
- Road-tested route and tour speeds;
- Reported vehicle downtime; and
- Back-up capabilities from other parts of the system.

Designers should drive over the likely vehicle routes at appropriate times of day to determine average tour speeds and to observe any potential operating hazards. This may have already been done in developing system configuration (Section 3.2.4). In addition, the implementation section contains suggestions for simulating demand as a basis for road-testing system design (Section 4.2.9).

(i) Calculation Procedures. The number of vehicles needed to serve a specific area follows directly from estimates of tour time and demand levels. This number will also depend on external service constraints, such as the need to link up with fixed-route schedules or to ensure that wait time never exceeds a pre-specified span. In the absence of external service constraints, it is only necessary to make enough vehicles available to meet the demand at the estimated number of pick-ups per tour:

$$N = \frac{DA_sT}{60n}$$

where: N = number of vehicles needed to serve the territory,
D = estimated demand, passengers per square mile per hour (peak-hour demand estimates reflect maximum vehicle requirements),
A_s = service territory area in square miles,
n = estimated number of pick-ups per tour, and
T = estimated tour time in minutes.

In the event that service constraints are imposed (e.g., the need to link up with fixed-route service), the number of vehicles needed depends only on tour time and specified service level (headway):

4.2.7 Target Mkt. Demand Estimation
D 3.2.4 Tour Design
3.2.8 Vehicle Selection
3.2.5 Detailed Demand Estimate
I 4.2.9 System Pre-Test
D 3.2.4 Tour Design

3.2.5

$$N = \frac{T}{h}$$

Where: h = maximum interval between successive vehicles, in minutes.

Vehicle requirements should be estimated separately for each service territory and summed for the entire service area.

Vehicle-miles can be estimated from the number of vehicles and the tour time and distance:

$$VM = \frac{60Nd}{T}$$

Where: VM = vehicle-miles per hour, and d = tour distance.

(ii) Additional Vehicle Needs. Operators may feel they need a greater percentage of spare vehicles for paratransit service than is required for fixed-route systems. Demand-responsive fleets are typically smaller and service levels are quite sensitive to the supply, making each vehicle more critical. If one fixed-route bus fails, only users on that route are inconvenienced, whereas the loss of a demand-responsive vehicle can degrade service for the entire system. A very general estimate of reserve needs is to allow 10 to 15 percent substitution capabilities, or provide one back-up vehicle for every six to ten operating vehicles.

Many systems also rely on an additional supervisory or maintenance vehicle (e.g., station wagon or van) equipped with mobile radio equipment for emergency parts delivery, driver relief, etc. This vehicle could be used for backing-up smaller two- and three-vehicle fleets.

If a paratransit system is being introduced as part of an existing regionwide system, the larger existing network may have sufficient interchangeable reserve vehicles so that additional vehicles need not be purchased for back-up purposes.

(iii) Fleet Size Limitations. The nature of their low-density operations dictates that dial-a-ride systems serving the general market will usually operate most effectively within a limited range of fleet sizes. Fleet size estimates should be compared against the outer limits of this range to determine if the proposed service area and system design are within the general range of proven dial-a-ride service effectiveness.

- Minimum fleet size. A dial-a-ride system serving the general market should require three vehicles or more to meet the travel demand. Systems smaller than this will not be cost-effective, since administration and dispatching costs will result in a high cost per passenger (Reference 60).

- Maximum fleet size. Fifteen to twenty vehicles represent the maximum number that can be effectively controlled through a single manual dispatch center offering many-to-many service. Both U.S. (Reference 60). and Canadian (Reference 4) experience suggests that manual dispatching procedures must be augmented with computer assistance in controlling more than 20 vehicles in many-to-many operations.

  For dial-a-ride fleets between 16 and 20 vehicles, manual dispatch operation may remain satisfactory if many-to-many service accounts for no more than one-third of the travel demand, with the remaining travel demand consisting of many-to-one vehicle tours, subscription service, and 24-hour call-ahead service (Reference 60).

If a fleet size of more than 20 vehicles is indicated for a particular service area, designers might consider dividing the area into smaller service zones. Where activity locations and travel characteristics permit, the proposed service area may be divided into two or more smaller service zones, each served by between 3 and 20 vehicles and controlled by a separate dispatching operation. Each new zone should then be reevaluated for patronage and fleet size. Trips between the service zones may be accommodated by establishing a central transfer point between two dial-a-ride systems at a major activity center or by developing a fixed-route bus line that serves major corridors within each service zone.

(C) Detailed Performance Estimates

More detailed performance models are available for estimating both fleet size and system performance (walk and wait times, trip times, vehicle productivity). These include:

- The Multisystems/Cambridge Systematics disaggregate model which balances supply and demand (Reference 172);
- The Multisystems macromodel, which has been adapted to the standard UTPS planning package (Reference 189);
- The SYSTAN SMART model, a macromodel which combines models of feeder, line-haul and distribution systems in a modular representation of the urban area (Reference 190);
- And several simulations which are too costly and unwieldy for use as design tools.

3.2.6 Design Tradeoffs

Once tour time, demand, and the number of vehicles have been estimated, it may be desirable to make some adjustments to produce a better overall design. Several trade-offs are available:

- Tour times may be adjusted by varying fleet size or service area;
- Vehicle productivity may be adjusted by varying service area or vehicle capacity; and
- Fleet requirements may be adjusted by varying service area or service options.

In addition, a number of sensitivity analyses may be undertaken to bound supply and demand estimates and to explore the impact of different parameters upon these estimates.

(A) Tour Time Tradeoffs

The Canadian Dial-A-Bus Manual (Reference 4) suggests the following tradeoffs for adjusting tour time and vehicle productivity:

- If the estimated tour time exceeds the maximum allowable time, it can be reduced by:
  - Reducing the size of the service area or relocating the base route in order to reduce the route length.
  - Increasing the vehicle fleet to reduce passenger waiting times or to accommodate the demand without modifying the level of service desired.
- If the estimated tour time is within the allowable limit, it is possible to increase vehicle productivity by:
  - Increasing the size of the service area or extending the base route in order to accommodate additional demand.
  - Using vehicles with larger capacity in order to carry additional passengers on each tour without modifying the level of service selected (Reference 4).

Care should be taken in the selection of service parameters to analyze the particular problem at hand. While general guidance is available, there are no universal rules to guide the designer. Similarly, one needs to approach the different design aids with caution. Simulation models and other complex micromodels are not generally recommended for direct design work. These aids are useful in a research environment, but they have too many imbedded assumptions for reliable design support. A printed computer output is a poor substitute for first-hand knowledge of the service area.

(B) Service Option Tradeoffs

Attempts to design a route structure to fit a pre-specified service option without a designated service area may lead to reassessing other available options, the area served, or both. Service options are not mutually exclusive. They may be mixed and matched to suit the demands of a particular travel market at a particular time of day. Service hours may also be adjusted to fit demand patterns. Service options include:

- Offer subscription service during peak periods and many-to-many demand-responsive service or other specialized services in off-peak time;
- Provide different services on different days of the week;
- Substitute flexibly-routed service for conventional fixed-route service during the midday hours in order to adapt service modes to daily variations in travel volumes and patterns;
- Enlarge the service area during the off-peak period to provide a wider choice of origins and destinations; and
- Provide service several days per week to each zone, but rotate among zones so that the daily vehicle supply is constant throughout the week.

Mechanisms should be developed to reallocate vehicles to new modes of operation on a dynamic basis.

(C) Sensitivity Analyses

During the design phase, it is desirable to undertake a variety of sensitivity analyses in an effort to become familiar with the theoretical limitations of the proposed system and to bound the anticipated range of performance. This may be accomplished by arbitrarily selecting high and low limits on demand, perhaps by using the experience of existing systems as a guide (see Section 3.1 in System Characteristics,) or by varying one of the system design parameters (i.e., fare or fleet size) to observe its impact on demand and performance. In estimating ridership, it is wise to consider a range of at least three alternative figures: a low estimate reflecting the most adverse of situations, a high estimate reflecting the most favorable, and an intermediate estimate reflecting the most likely level based on planning and design analyses. These analyses may be undertaken using the models applied in the planning process (Section 2.2.10).

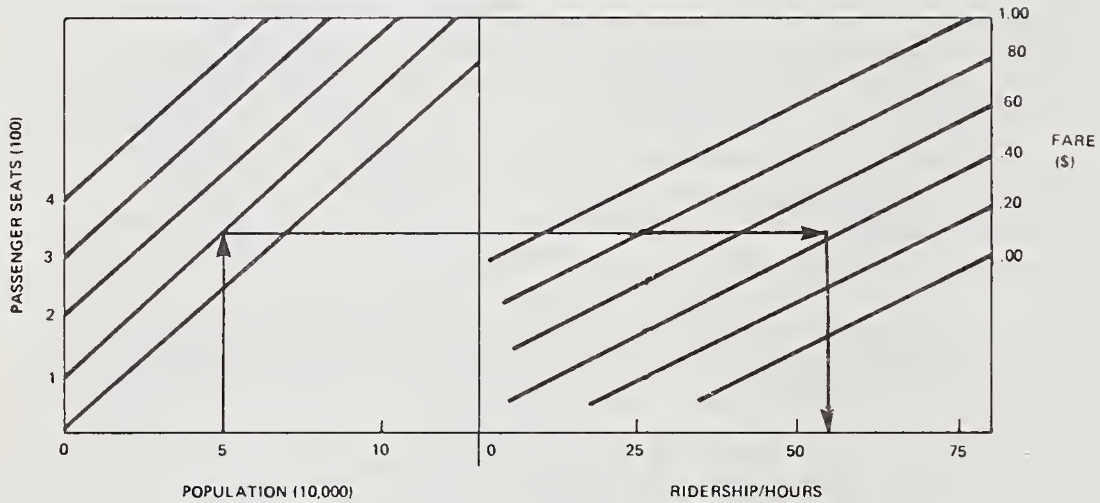
As an alternative to the planning models, different modeling approaches may be used to provide an additional dimension to the sensitivity analyses. Subsequent subsections discuss different approaches to balancing supply and demand estimates and estimating the impact of different fare levels on ridership.

(i) Balancing Supply and Demand. The interlocking relationship between supply and demand is particularly complex in paratransit systems, since the quality of service generally suffers as demand increases, and improves as demand declines, thereby working against prevailing ridership trends. Several modelers have prepared iterative techniques which simultaneously balance estimates of supply and demand in paratransit systems. The most reliable of the simpler approaches appears to be a set of nomographs developed by MITRE in 1973 on the basis of data from 16 DAB operations (see Reference 188). This model uses data on population and population density of the service area, fare, expected travel time (wait time + ride time, in minutes), and the type of service offered (e.g., many-to-many). Using the set of nomographs on the following page, the analyst begins by using the population, number of passenger seats, and fare to provide an estimate of the number of riders per hour of operation. In the illustra-

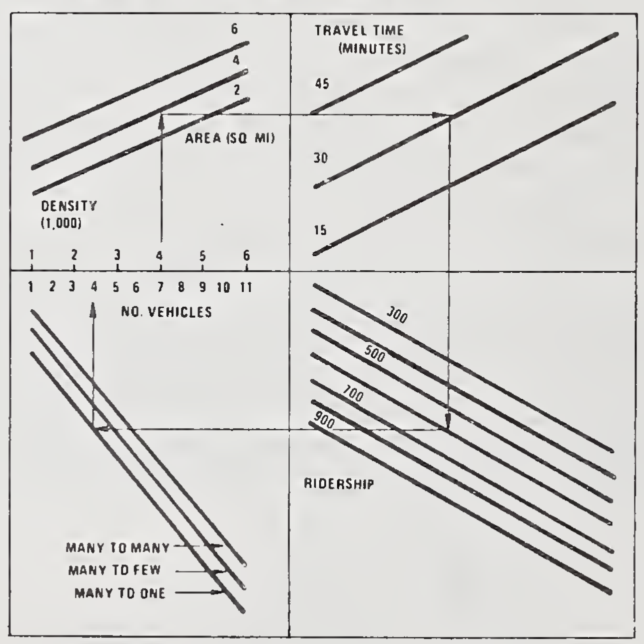
3.1
Operational Data
on Existing Systems

2.2.10
Models for
Estimating
Supply and Demand

Nomograph for estimating ridership per hour of operation.



Nomograph for estimating vehicle supply.



(Source: Arrillaga and Medville, Reference 188)

ted example, a fleet size of 100 passenger-seats per day and a fare of $.40 in a service area containing 50,000 people produces an estimate of 56 riders per hour of operation. This ridership level, translated in daily terms, becomes one of the parameters used in generating a fleet size estimate in the lower nomograph. There is no guarantee that this fleet size estimate will be consistent with the estimate of passenger-seats used in generating the initial estimate of demand. If it is not, a new estimate of passenger-seats should be formulated, using the information generated from the first iteration, and the process repeated until consistent estimates are obtained. In this way, the supply-demand feedback is simulated, and the designer is afforded an insight into the estimated impact of each variable on supply and demand.

(ii) Assessing the Impact of Fare Levels. Information regarding the impact of fare levels on demand-responsive systems is relatively scarce and difficult to interpret. The facing exhibit summarizes data on demand elasticity with respect to fare for a sampling of fixed-route transit systems, demand-responsive transit systems, and exclusive-ride taxis. Additional information regarding the experience of operating demand-responsive systems in instituting fare changes can be found in the Operations section (Section 4.2.2(D)).

Although site-specific circumstances make it difficult to generalize on the experience gathered to date, it appears that elasticities in demand-responsive systems and fixed-route systems are similar. Demand is relatively inelastic (-0.3 elasticity or lower, meaning that a 1% increase in fares results in a -.3% loss of ridership, which results in a net increase in revenues) at low fare levels in the 25¢ range. As the fare increases, demand becomes increasingly sensitive to fare changes, with

5.2.2(D)
Changing Fare
Structures

SUMMARY OF DATA ON DIRECT DEMAND ELASTICITY WITH RESPECT TO FARES

SOURCE	SERVICE	ELASTICITY
Curtin (1974)	Fixed-Route Transit	-0.33
Caruolo (1974)	"	-0.33
Wohl (1974)	"	-0.3 at low fares to -1.0 at $0.75
Arrillaga & Medville (1973)	Demand-Responsive Transit	-1.5 x $fare
Ziegler (1977)	"	-1.3 x $fare
Mouchahoir (1974)	"	-0.6 to -0.75 at $0.60 fare and -1.1 x fare
Golob & Gustafson (1971)	"	-1.1 at $1.00 fare
Hartgen & Keck (1975)	"	-0.61 at $0.75 to $1 fare
Stalians (1977)	Exclusive-Ride Taxi	-0.49 at $4.00 fare
Samuels (1977)	"	-0.79
Davidson (1977)	"	-0.3
Kirby (1974)	"	-0.8 to -1

(Source: DAVE Systems, Reference 93)

elasticities of -0.7 occurring around the 50¢ fare level and -1.0 or greater characterizing fares of 75¢ or more. At higher fare levels, fare increases can generally be expected to cause disproportionate ridership drops, with consequent losses in total revenues. Even at high fare levels, however, demand appears to be relatively inelastic for a captive market in automobile-oriented, low-density communities. In such settings, elasticities on the order of -0.5 can be expected (Reference 93).

If in doubt regarding an appropriate starting fare, it is probably advisable to select a higher initial fare rather than a lower fare. If a subsequent adjustment is necessary, it is easier to lower fares than to raise them. Furthermore, a low initial fare may generate too much demand for the fledgling system to handle, resulting in poor service, a poor public image, and permanently lost ridership.

Each patronage estimate needs to be subdivided into the special fare groups, if any, so that the expected revenue can be calculated. If it is not possible to make clear predictions for all fare groups, a logical argument should be prepared for each group that can serve as a basis for a quantitative estimate. For example, hostility toward a new service on the part of social service agencies, coupled with their determination to continue providing individual transportation services, could lead to low patronage by the clients of these agencies. In contrast, overwhelming support and word-of-mouth promotion by social service agencies could lead to very high patronage by their clients. Despite indications of support, the exact reaction of the social welfare agencies cannot be predicted in advance. Their reaction will depend in part on their perception of the quality of service being offered to their clients.

3.2.7. Select Fare Structure and Collection Method

The broad fare policy established during the planning phase (see Section 2.2.9) will need to be translated into specific rates and procedures in the design stage.

(A) Fare Structure

The designer begins with a revenue goal and estimates of patronage, preferably by fare category. The site boundaries and the nature of the trips that are expected should also be known. The first step in the structural analysis is to explore the range of feasible fares. The easiest starting point is to add a contingency (e.g., 20 percent) to the required daily revenue and divide by the expected daily patronage, giving the revenue required per passenger. If it is low, there may be no need to consider anything other than a fixed fare. If it is excessively high, it may be necessary to go back to the policymakers for relief or to consider a somewhat modified and less costly design. Other factors to consider are:

- Funding constraints;
- Community political considerations;
- The person or agency which regulates fares;
- A pricing mechanism that is simple, fraud-proof and inexpensive to administer;
- A rate scheme that encourages drivers to make trips as quickly and efficiently as possible; and
- Rates regulated so that fare levels can be increased as variable costs increase.

2.2.9
Fare Policy

If the revenue required per passenger falls between $0.25 and $1.00 per rider, the designer is in a position to explore structural options. It is wise to examine a number of alternatives. The facing exhibit lists the principal choices together with their features, advantages and disadvantages. Zone fares allow the designer to charge more for longer rides, but these fares may be difficult to administer in flexibly-routed systems and are not generally attractive when most rides are relatively short. Similarly, mileage fares are particularly unattractive where many passengers are forced to ride out of their way to accommodate other riders. If a complex computation system is not installed, riders may perceive that they are paying more for roundabout routes, which are undesirable besides.

(B) Special Fares

The ability to offer special fares is one attractive feature of demand-responsive systems, and most existing systems employ one or another of the structures listed below.

(i) Transfer Fares. Transfer fees are a mechanism for providing joint service between the demand-responsive system and a fixed-route system. They can also be a mechanism for cross-subsidizing the demand-responsive service. The transfer fee may give the passenger a reduced rate for his feeder and distribution trips. An agreement needs to be reached with the fixed-route operator whereby the demand-responsive service does not pay a disproportionate amount of the fare inducement. For an equitable integration of paratransit and fixed-route service:

- Check regulations relating to fare structure and their impact on interservice transfers (i.e., feeder to line-haul)

FARE COLLECTION OPTIONS

OPTIONS	DESCRIPTION/DEFINITION	WHEN IS FARE COLLECTED?	HOW TO USE	ADVANTAGES	DISADVANTAGES	EXAMPLES
BASIC FARE:						
Flat Fare	All passengers pay same amount for trip anywhere in service area.	-Upon entering vehicle.	-Small service areas. -Relatively uniform trip distances. -TM services.	-Easy to install and administer. -Easy for riders to use. -Minimize accounting and stop time.	-Recipients of Federal Grants must offer ½ fare to E & H. -Inequitable. -Encourages long, yet discourages short-distance riders.	Topeka, KS DAB/#29
Mileage Fare	Passengers pay according to distance travelled.	-After completion of trip.	-Base on direct point-to-point distance when detours are necessary for shared-ride. -Supplement with flag-drop and/or live clock charge. -Popular taxi structure.	-Most equitable. -Other features can be added (e.g., flag drop/ live clock).	-More complex calculation. -Higher potential cost-automated equipment required.	Palo Alto, CA SRT/#9
Zonal Fare	Incremental fare increases as rider crosses designated zone boundaries.	-After completion of trip.	-Relate boundaries to break points in passenger volumes, trip characteristics, natural boundaries or route configurations. -Overlapping/flexible borders may eliminate short trips costing 2-zone fares -Keep number of zones to minimum.	-Low-cost service for short trips. -Different amounts charged for different trip lengths -2-zone structure easy to install/administer.	-Creates anomalies near zone boundaries. -Multi-zones confusing for passengers.	Western, NE DAB/#30 Madison, WI SRT/#63
SPECIAL FARE:						
Transfer Charge	Passengers pay surcharge for moving from one service and/or vehicle to another; less than 2 separate fares.	-Upon entering first service vehicle, obtain transfer slip.	-Coordination/integration of services. -Large psychological barrier greater than actual time/ level of service required in transfer.	-Reduce total charge to rider. -Assist integration efforts.	-Increases fare complexity. -Discourage transfers. -Decrease ridership.	Midland Co., MI DAB/#100 St. Bernard Parish, LA SRT/#50
Express Charge (Commuter)	Passengers pay surcharge for faster service; eliminates intermediate stops.	-Upon entering vehicle.	-Integration with feeder-service. -Provide higher level of service for those willing to pay. -Limited operating experience.	-Equitable-riders pay for higher level of service.	-Increases fare complexity. -Decrease ridership by eliminating number of stops. -Decrease potential revenue.	
Group Fares	Reduced price for several riders travelling together. (Same O and D).	-After completion of trip; billing/charter option.	-Social service organizations. -Usually prearranged. -Economical option for riders desiring same trip (e.g., shopping).	-Increase ridership.	-Increase fare complexity. -Increase monitoring, accounting problems.	Grand Rapids, MI DAB/#15 El Cajon, CA SRT/#60
Target Market Fare	Special identified users pay reduced or no fare.	-Flexible (e.g., upon entering, after completion, prearranged, later billing)	-Elderly, handicapped, low-income or youth. -GM pays full cost; set TM fares at marginal cost of providing service.	-Increase target market ridership. -Achieve social objectives. -Federal grants must offer ½ fare to E & H.	-Increase fare complexity. -Decrease revenues. -Riders paying full fare are subsidizing service that should be provided by broader fiscal support.	Free: Tucson, AZ #1 Half-fare: Marshall, MI #16
Off-Peak Fares (Weekends-Owl fares)	Lower fares charged during periods of decreased demand.	-Upon entering or exiting vehicle.	-Simple, low-cost mobility for unemployed, handicapped, elderly, low-income, students, etc. who do not have to travel at peak hours. -Peak riders bear marginal costs of additional high-demand hour services.	-Increase off-peak ridership. -Equitable. -Improve utilization and cost.	-Increase fare complexity. -Decrease revenue. -Difficult to establish size of fare differential.	Worcester, MA DAB/#20 Claremont, CA SRT/#74
Flexible	Passenger purchases scrip/tokens from variety of sources at different prices. Sponsor agencies buy scrip/tokens at full-price, underwrite their patrons/customers.	-Upon entering vehicle.	-Gives operator fixed revenue per ride. -Any business, agency can subsidize its customers. -Could have two-ride categories. -Limited operating experience.	-Any agency can support use. -Security control outside transit agency. -Easy for operator, driver.	-May be awkward to buy tickets. -No good mechanism for peak/off-peak fare differential. -Passengers need seek-out scrip supplier.	Portland, OR #59

(Source: Developed from several references by SYSTAN)

- Decide on fare structure
  - Free transfer
  - Charge for transfer
  - Integrated fare structure
- Assess financial impacts of fare structure on system revenues
- Set up joint fare agreements where necessary between systems if operators are different

(ii) Group Fares. Group incentive fares may encourage groups of travelers with a common destination to gather at one origin (or checkpoint) and thereby save the operator time and money. Group fares may add riders at little or no marginal cost to the operator.

(iii) Target Market Fares. Target market fares are required by law for elderly and handicapped passengers if the operator receives federal capital or operating grants. Fare reductions to target groups might be offset by grants from social welfare agencies whose patrons use the demand-responsive service in lieu of agency-provided service.

(iv) Reduced Off-Peak Fares. These fares are intended to encourage riders to use the demand-responsive service during the day and in the evening.

(v) Flexible Fares or User Subsidy. The flexible fare structure is a recent innovation (Reference 46) that has had little field-testing to date. Under this structure, the driver charges a flat fare which is payable in cash, scrip or token. A wide range of business and agencies are encouraged to sell scrip /tokens for the benefit of their patrons. A business may offer scrip to customers in much the same way that they now underwrite parking charges. Social welfare agencies might sell or give scrip to their patrons to meet their transportation needs. Scrip might be distributed to needy families through the channels that now distribute food stamps. This scheme assures full revenue for the transit operator while providing a great deal of flexibility to a variety of transit sponsors. (See User Subsidy exhibit for examples.)

The designer can experiment with a variety of these fare structures, using different fare levels until one is found that meets the tests for equity and clarity and that shows promise of producing the needed revenue. When a suitable structure has been found, the designer is ready to explore fare collection techniques.

(C) Fare Collection

Fares can be paid in a variety of ways (see exhibit). However, many operators agree that cash should be avoided where possible. Fare collection is a serious business. With anything but a fixed fare scheme, it is difficult, and expensive, to prevent abuses of fare collection. Experience can site numerous examples of abuse, such as the unscrupulous driver who takes fares "over the top of the box," or admits friends without fares. The abuses are almost impossible to prevent and, at best, they can be reduced to the point of indifference.

Other means of fare collection (tokens, scrip, tickets, passes) do not eliminate the pilferage problem, but they transfer it outside the vehicle where it is more easily controlled. There may be no economical way to prevent a ticket clerk from selling tickets to his friends

USER SUBSIDY

Initiation of user subsidies should begin only after the system has been implemented and is operating in a satisfactory manner, so that the benefits to the subsidy sponsors are apparent. User subsidies should not be implemented until the groups to receive the benefits and the sponsors to supply the subsidies are clearly identified.

Examples of User Subsidies

- In Petersborough, Ontario, passengers use the taxi service as feeders to the bus system. They pay the regular bus fare plus a 10-cent premium for the taxi service and receive a transfer. The taxi operator is paid the regular taxi rate minus the fares collected by the City upon receipt of a monthly invoice supported by a detailed log of trips.
- In Los Gatos, California, elderly and disabled residents can purchase up to 10 taxicab tickets per month from the City at 50 cents per ticket and use these tickets at the rate of one per trip for taxi travel anywhere within the city limits. The taxi operator is paid $2.10 for each ticket he turns in to the City.
- In Danville, Illinois, elderly and handicapped residents purchase shared-ride taxi services from the provider of their choice by paying 25 percent of the regular fare and signing a voucher for the remainder of the fare. The taxi operator then submits the voucher to the City and is reimbursed for the amount shown.
- In Raleigh, North Carolina, some social service agencies subsidize taxi services for their clients by means of a two-part ticket. On completion of a taxi ride, the driver records the fare on both halves of the ticket and gives one half to the rider. The driver obtains the rider's signature on the other half and submits that half to the social service agency for reimbursement. In this example, the social service agency covers the full fare.
- In Arlington County, Virginia, certain elderly residents were allowed to make taxi trips anywhere within the county for a flat payment of 15 cents. The taxi operator computed each fare with the taximeter, and billed the county for the total fare less the 15 cents paid by the user.
- In Joplin, Missouri, the City purchases taxicab coupon books from the taxi operator and then makes them available to low-income residents at a 70 percent discount. Thus, the taxi operator gets paid for the tickets regardless of whether they are used or not.
- In Evansville, Indiana, 100 elderly and handicapped persons pay $2 to $3 per year for $6 worth of transportation tickets that are valid on taxis, dial-a-ride, wheelchair transport and conventional transit.
- In Winston-Salem, North Carolina, social service agencies purchase transportation stamps that are valid on taxi, dial-a-ride, subscription and fixed-route services. Agencies issue stamps to their patrons, charging whatever price they choose.

(Source: N.D. Lea, Reference 46, with additions from SYSTAN survey)

FEATURES OF FARE EXCHANGE

FARE	DESCRIPTION	TERM OF VALIDITY	PLACE OF PAYMENT	ADVANTAGES	DISADVANTAGES
Cash: (cash available)	• Driver access to cash for making change for riders		• On-board vehicle	• Convenient for users • Encourages riders by using standard available exchange	• Unsafe/security problem • Driver must handle cash
Cash: (exact amount required)	• Driver has no access to cash; rider deposits fare into locked collection box		• On-board vehicle	• Security • Reduces time bus is stopped	• Inconvenient for users to carry exact change; may need to overpay
Tokens or Scrip	• Rider deposits coins into manual or automatic collection device	• One-time use, or • Specified time limit, or • Limited number of uses	• General offices • Information/transfer stations • Banks/sales outlets • Employers • Social service organizations • On-board vehicles • By mail	• Security • Subsidies easily applied	• Tokens not reuseable • Confusing for infrequent riders
Tickets	• Rider tears off stub or driver punches out section of ticket equal to fare; or magnetic-coded tickets used for automated collection			• Security • Subsidies easily applied • Different tickets or number of tickets available for different services - aid integration of paratransit	• Punching tickets is time-consuming • Tickets not reuseable • May confuse infrequent riders
Passes	• Rider displays card/photo I.D. to driver, or inserts magnetic-coded pass in automated collection devicé-pass returned to rider	• Weekly • Monthly • Annually		• Reduced accounting problems • Reduce time at stops • Security • Convenient for frequent user • Subsidies easily applied	• Theft or loss of pass • Not suitable for infrequent riders

(Source: Developed from several references by SYSTAN) at senior citizen rates, but if two separate ticket categories are identified and accounted for, the loss may soon be discovered.

The principal disadvantage of non-cash fares is the inconvenience to the passenger. One may be more willing to accept this inconvenience if there is some financial incentive to do so.

There is a variety of fare collection equipment, ranging from manual to automatic (see exhibit). There is little basis for adopting automatic fare collection for demand-responsive services. A driver is always present to enforce fare collection. There are no fixed stations where ticket agents or ticket-selling equipment could be effectively placed. Finally, automated fare collection equipment is simply too expensive for most systems.

Fare collection should provide reasonable security. Locked boxes for exact-amount fares are reasonably secure, but not vandal-proof. Fare collection and computation should be easy and fast for the driver. Credit card systems that require the driver to fill out a charge ticket are simply too slow. Magnetic charge systems are fast but expensive.

FARE CALCULATION AND COLLECTION

TYPE	DESCRIPTION	ADVANTAGES	DISADVANTAGES	ADDITIONAL COMMENTS/FEATURES
Manual	• Driver calculates charge according to fare structure and accepts payment in cash, token, scrip, ticket or pass	• Reduces capital costs • Fare collection options unlimited	• Causes accounting problems • Limits fare calculation complexity • Increases time at stops	• Drivers must be kept aware of any special tokens, tickets or passes, in addition to regular fare structure to avoid conflicts or discrepancies with riders, especially for fare promotional efforts.
Automated	• Meter computes charge according to established fare structure and accepts exact fare in cash, tokens, magnetically coded tickets, passes or credit cards	• Reduces time at stops • Reduces accounting problems • Allows complex calculation	• High capital costs • Fare payment options limited • Back-up system required	• Can be combined with automated office accounting systems • Can use a sliding scale to enable discounts or subsidies for certain users • Time and distance factors made accountable
Combination	• Manual calculation with automated collection • Automated calculation with manual collection	• Flexible • Reduces time at stops	• High capital cost	• Can be combined with automated office accounting systems

(Source: SYSTAN)

3.2.7

(D) Driver Incentives

The greatest threat to the financial success of demand-responsive systems is driver lethargy. The indifferent driver who executes his duties, but only as required and with little interest, will lose more customers than an aggressive marketing plan can attract. Taxi operators have attacked this problem by paying drivers a fraction of fares received. Demand-responsive services need a mechanism that will encourage the drivers to high productivity. This can be a share in the fares, a bonus for productivity achievement, or a similar payment. Financial rewards can be supplemented with rewards for courtesy, vehicle care and other factors that are important to the operator but largely under the control of the drivers.

3.2.8 Select Vehicles

The largest capital investment for any demand-responsive system will be for vehicles. Demand-responsive transportation includes such a diverse set of services that a broad range of vehicles, from automobiles (taxis) to full-sized buses, are currently used to meet service needs. When selecting vehicles for your particular system, let local operating conditions be your guide. The types of vehicles currently in use in demand-responsive services are summarized in the accompanying table.

Demand-responsive transit operators generally use smaller vehicles with greater maneuverability and lower capital and operating costs. In general, small vehicles have a lower first cost than large vehicles; however, fuel costs are comparable for most vehicle sizes, and it is difficult to substantiate differences in maintenance costs among different vehicle sizes and types. As a result, long-term vehicle cost is not the principal determinant of vehicle size. The important factors include:

- A common vehicle type greatly simplifies maintenance needs;
- A common vehicle size provides maximum flexibility for a vehicle fleet, and opens up the possibility of multi-user vehicle pooling;
- Demand-responsive services may require vehicles to maneuver in cramped areas that would preclude large vehicles;
- Special equipment for target market passengers may require special vehicle types;
- Special service opportunities may require large vehicles; and
- Periodic peak demands may exceed the capacity of small vehicles.

These factors need to be balanced against the desire to save capital funds. In each case, weigh the degree to which existing vehicles and vehicle sizes satisfy the need. The final choice may be determined by opportunities for adjunct services.

(A) Pinpointing Exact Needs

Smaller vehicles (i.e., van, automobile) are preferred for handling immediate service requests and for covering areas with low population densities, where it is difficult to group large numbers of passengers. When compared to a small bus that may hold three times as many riders, two or three smaller vehicles can cover more area at greater schedule and service efficiency with a comparable capital investment. However, the resulting improvement in service should be weighed with the higher operating costs that will be incurred from using more drivers and vehicles. Existing system documentation for 33 systems shows that over 85% of the very personalized automobile-based systems offer many-to-many service in a short response time.

Vans may prove more efficient for some systems, particularly those with small service areas (under five square miles) and higher population densities (Reference 199). The standard dial-a-bus vehicle in Michigan is a moderate-to high-cost converted van; these vehicles are economical and come equipped with an intermediate number of seats,

3.2.8

VEHICLE FEATURES

Vehicle Type	Passenger Capacity	Capital Cost ($1000's)	1975 Operating Costs ($ per mile, excluding labor)	Service Life (Years)	Maintenance		Performance/ Safety	Ease of Entry/Exit	Interior Features
					Ease	Record			
Automobiles and Sedans	4-9	5	.09	2-4	Extensive service network; competitively priced	Fair; limited durability	High maneuverability and acceleration. Relatively high accident rate	Limited or difficult due to low, sleek design; no wheelchair access	Limited seating arrangements; poor space utilization
Vans and Converted Vans	8-17	7-14	.11	4-7	Fairly extensive service network; competitively priced	Fair; limited durability	High maneuverability. Increased safety due to elevated driver position	May be difficult in standard vans or if seating cramped; wheelchair access	Versatile seating
Small Buses	15-30	15-42	Generally higher than vans, but varies widely according to type	5-10	Limited to trained bus (diesel) specialists	Fair to good; durable	Less maneuverability than vans; smoother ride in unitized construction; safety track records not available	Increased size and comfort permits easier boarding; wheelchair access	Greater versatility and passenger comfort
Converted Motor Homes	15-25	Generally less expensive than small buses but prices vary widely; 14-65	N/A	N/A	Limited to trained specialists	Track record not available; questionable durability	Limited maneuverability; safety track records not available	Wheelchair access	Versatile seating
Regular and Mid-Sized Buses	30-50	40-55	.60	12-25	Limited to trained bus diesel specialists	Excellent; reliable and durable	Limited maneuverability; relatively low accident rate	Increased size permits easier boarding and wheelchair access	Versatile seating

(Source: Developed from several references by SYSTAN) N/A = Not Applicable making them adaptable to a wide range of service areas and operating characteristics.

Larger vehicles (minibuses and motor homes) become more attractive as the factors of access time, population density, and shared-ride potential increases. The distinction between converted motor-homes and small buses is not always clear, but it is intended to differentiate those vehicles whose motor-home body was merely modified for transit use from those vehicles primarily designed for use as buses. System documentation shows that the majority of minibuses are used in the more intensive dial-a-ride operations, with over 20% offering many-to-one service, and over 70% offering subscription service. They have the durability of large buses, but at greater cost than the van option. Minibuses are thus recommended for high-demand services.

For all small operations, a uniform type of vehicle is recommended. Operators of larger fleets may have more flexibility in vehicle selection, since they can initially select vehicles for service start-up and then expand the fleet based on local service experience and marketing conditions.

AVOID MIXING TOO MANY VEHICLE TYPES AND MODELS.

(B) Rank Performance and Service Criteria

Consider each of the following service operating characteristics in narrowing the range of vehicles available for local use. You may need to refine fleet size based on such criteria.

(i) Maneuverability. Service area topography and special traffic constraints should be considered when evaluating engine power, transmission and differential requirements. Continuous stop-and-start operations on hills make low-gear ratios desirable (Reference 4).

Hilly routes with more than a few short grades over 6% would indicate the need for lower-gear ratios in final drive (differential). If these same vehicles have to cover long distances on high-speed highways (stretches more than 10 miles several times a day), either an overdrive transmission or intermediate final-drive ratio might be chosen. Operations on steep grades are safer and engine and driveline components are longer-lived if the final drive ratios are "low", that is, a larger gear ratio numerically. (Reference 56)

In general, vehicles in urban areas should also be able to negotiate narrow residential streets, and to complete turns in a diameter of 45 feet or less. Only limited reverse operation is required and power-steering is highly desirable for these systems.

(ii) Regulations. Review Section 2.2.4(A), as every vehicle must meet all applicable local, state, and federal motor vehicle safety and environmental standards. California imposes stringent air emission control requirements.

(iii) Safety. In general, the smaller the vehicle, the greater risk to passenger safety. All vehicle structural reinforcements that can be added are recommended. Internal safety features should include non-skid floor coverings, grabrails, interior padding of fire-resistant materials, and emergency exit provisions. For nighttime service, include stepwell lights.

2.2.4(A)
Regulatory Issues

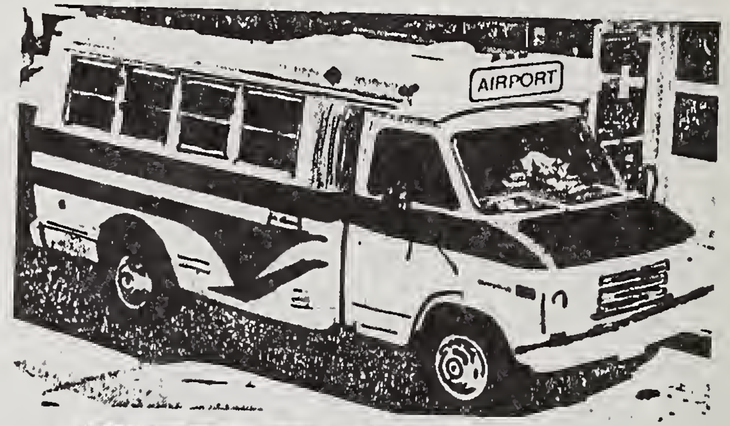
(iv) Comfort. In forward seating arrangements, space seats a minimum of 30 inches center-line to center-line with contoured foam and spring support seat cushion. Allow 18 inches width per passenger.

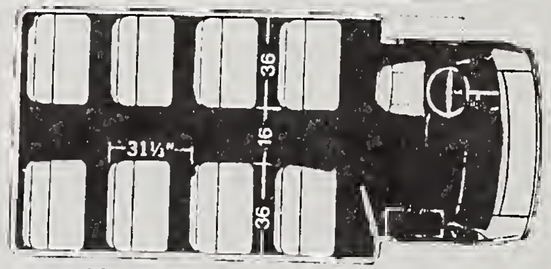
For peripheral arrangements, minimize stop and start discomfort by using arm-rests. Angle seating, as used in Haddonfield's Twin Coaches, allows more leg room than forward-facing seats and more seating room than peripherally arranged ones, but reduces seating capacity. Heating and air conditioning systems should be installed as climate conditions merit.

(v) Quality of Ride. Ideally, a ride by paratransit should be as enjoyable as riding in one's own automobile. For a smoother ride, select all suspension vehicles with such features as heavy-duty shock absorbers, high-capacity springs and axles, and special bearings. Excessive vehicle noise can make even short trips unpleasant. Choosing a gasoline-powered vehicle rather than one with diesel power will eliminate some engine noise; also, additional sound-proofing may be specified around the engine compartment. Adequate power-to-weight ratio will permit quick acceleration and easy maintenance of normal traffic cruising speed. Automatic transmission is also recommended.

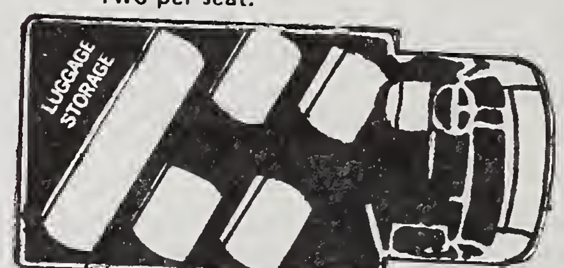
(vi) Ease of Entry and Exit. Doors at least 30 inches wide and 74 inches high will permit full height passage. A first step of 12 inches or less is recommended for general market services. If the passenger list frequently includes the elderly, handicapped, bag-toting shoppers, and parents with baby-strollers and children, then lower steps, ramps, lower floor level and wider doors are recommended modifications. Refer to System Characteristics Section 4.2.8 for target market equipment specifics.

4.2.8
Target Market
Equipment





16 Adults.
Two per seat.



13 Adults/Luggage Storage at rear.
Two per seat, five on couch.

15 Adults.
Five per couch.

(vii) Costs. Evaluate the service versus cost (efficiency) tradeoff: compare vehicles with high capital cost/low operating and maintenance expenses against vehicles requiring low initial investment but high operating costs.

Useful vehicle life can range from two to four years for automobiles and less-costly vans up to 25 years for conventional transit buses, depending on the model and the operating conditions. The typical gasoline-powered small bus has an expected life of approximately 100,000 miles (160,000 kilometers). Thus, two or more generations of smaller vehicles may be needed to equal the total life of a larger or more durable vehicle (Reference 44). The facing table illustrates one method of comparing vehicle costs by equating capital, operating and maintenance costs. In this particular case, the expected equivalent annual costs for the vans are slightly less. The operator may still elect to buy the smaller buses for their greater reliability and larger passenger capacity.

(viii) Fuel Economy/Environmental Impacts. The smaller the vehicle, the greater the fuel consumption and resulting air pollution per passenger. Vans average about eight miles per gallon, whereas small buses travel approximately five miles per gallon. Diesel engines are generally considered more fuel-efficient than gasoline engines, raising small bus efficiency to above 10 miles per gallon. However, the higher noise level and diesel odor may preclude diesel-powered vehicles, especially for local residential service. Other factors that will affect the performance include the use of heavy-duty winter or studded tires (where permitted by law) and general wear from extreme weather.

ILLUSTRATE VEHICLE-COST COMPARISONS

Suppose that a potential paratransit operator has collected the following data on two alternative vehicles:

Alternative A:	Van
Capital Cost:	$10,000
Expected Annual Mileage:	25,000
Expected Life:	4 years
Operating Cost:	0.11 per mile
Maintenance Cost:	0.07 per mile
Capital Recovery Factor (10% interest, 4-year life):	0.31547
Alternative B:	Small Bus
Capital Cost:	$33,000
Expected Annual Mileage:	25,000
Expected Life:	10 years
Operating Cost:	0.08 per mile
Maintenance Cost:	0.04 per mile
Capital Recovery Factor (10% interest, 10-year life):	0.16275

The operator can then compare the two alternatives on the basis of equivalent annual cost, provided he knows how much interest must be paid for his capital. If capital were available at 10% interest and if the above cost data are true, then:

	Van	Small Bus
Equivalent Annual Cost of Capital (Capital Cost X Capital Recovery Factor)	$3,155	$5,370
Expected Annual Vehicle Operating Cost (Expected Mileage X Cost/Mile)	2,750	2,000
Expected Annual Maintenance Cost (Expected Mileage X Cost/Mile)	1,750	1,000
Equivalent Annual Cost of Vehicle Operation	$7,655	$8,370

(Source: SYSTAN)

The strains of local climate conditions on vehicle operation and passenger comfort need to be considered. Electrical systems must be adequate to cold-weather start-up in certain areas. Whether or not vehicles can be garaged or are stored outdoors in non-service hours should also be anticipated in judging the extent to which heavy-duty batteries, etc. will be necessary (Reference **141**).

(ix) Aesthetic Considerations. Complex exterior designs and miscellaneous add-on gadgets should be used sparingly. Some small additions can be made at less expense after the vehicles are delivered.

(C) Maintenance

Maintenance records should be one of the most important considerations in selecting a vehicle and in determining the type of maintenance program needed. Although demand-responsive transit maintenance is probably not significantly different in concept from maintenance of other automotive vehicles, each vehicle type will have its own idiosyncracies which must be learned and incorporated into a maintenance program.

(i) Maintenance Program. An effective maintenance program and schedule can minimize repair and operating costs, reduce the number of vehicles out of service, and improve the reliability of vehicles in service. Choosing a good maintenance team is essential to running an efficient, reliable service; using inexperienced mechanics will inevitably increase vehicle downtime and lower overall system productivity. In general, local garages can repair automobiles and vans, whereas larger vehicles should be assigned to bus maintenance specialists. Therefore, make sure the maintenance team has or receives adequate training.

Although no standard maintenance policies and practices for paratransit vehicles have been established, dial-a-bus managers can anticipate and then monitor the maintenance required for each vehicle to avoid or minimize unexpected repairs and vehicle failures. To do this, individual vehicle records must be maintained and periodically tabulated. Performance will be influenced by road and weather conditions, traffic density, driving styles, distance between stops, length of trips, and idling time, as well as the age and type of vehicle.

Dial-a-bus vehicles generally require more preventive maintenance, and are not as reliable as standard-sized buses. Standard small vehicles are usually not designed for continual stop-and-start service and, as a result, may frequently end up in the repair shop. Batavia, New York attributed its records of frequent brake realignment (every 5,000 miles or 8,000 kilometers) and drum replacement (every 10,000 miles or 16,000 kilometers) to the number of stops required in service.

Managers need to develop maintenance schedules using vehicle-miles as the dependent variable. Data should be compiled on fuel, coolant, oil, batteries, etc. to permit vehicle comparisons and to monitor excessive vehicle wear.

(ii) Maintenance Capabilities and Costs. Up-to-date records should be kept on all parts purchased. Each driver can help in this task by making daily vehicle checks and keeping a daily record of maintenance needs. All labor costs need to be recorded; if possible, divide costs according to cleaning, inspection, preventive maintenance, major repairs and road service. This information can give the manager some idea of the relative costs for each portion of the program and provide the basis for future maintenance contracts.

Developing total in-house maintenance capabilities is a major step, and would only be appropriate for operations generally larger than 10-15 vehicles, although contracting for maintenance remains a highly satisfactory option even at this level. While existing experience is limited, it appears that demand responsive services can contract for major repairs with an existing transit maintenance service or local garage at less expense than doing the work in-house.

Maintenance costs for existing systems seem to run between 8 and 20 percent of total operating costs(including labor), with the cost per vehicle ranging from less than $500 up to about $3700 (see exhibit below). Some sources have estimated demand responsive vehicle maintenance costs to range between $.28 and $.42 per hour (Reference 1), but the survey indicates that costs run much higher.

It is unclear which is the most reliable and hence least costly vehicle type: vans or buses. In the systems which use both and for which there is published data, the vans are usually new and, hence, a valid comparison of reliability is not possible. The following exhibit contains the maintenance costs per vehicle-mile for buses and vans in Ann Arbor, Michigan. The bus maintenance costs are about 73 percent higher than van costs, but the buses are large rather than the small models more appropriate for most paratransit services.

Radio system and equipment maintenance must be done by licensed technicians, and should only be considered as an in-house function for demand-responsive systems of 50 vehicles or more (Reference 44). A contract with the distributor, a local radio shop, or possibly city or county communications department may be possible, depending on the warranty coverage or limitations. If equipment is leased, maintenance costs can be covered in the written agreement. Equipment maintenance costs usually average one to two percent of total operating costs.

EXAMPLE OF MAINTENANCE COSTS

SYSTEM			VEHICLES			MAINTENANCE COST				TOTAL OPERATING COST
Location	Survey No.	Type	Number	Type	Annum Cost	Total	% of Operating	$/Mile	$/Hour	
Fairfield, CA	4	GM/OAB	5	Van	$2,765	$13,825	9	.076	1.16	$153,725
Merced, CA	10	GM/OAB	4	Van	3,105	15,527	15	--	--	105,680
Turlock, CA	14	GM/OAB	4	Van	2,592	10,369	11	--	--	93,528
Alma, MI	19	GM/DAB	4	Bus	3,220	12,880	11	.159	1.56	118,608
Gladwin, MI	30	GM/DAB	3	Van	460	1,360	8	.037	.30	17,000
Grand Haven, MI	31	GM/OAB	7	Van	1,598	11,184	19	.05	.74	59,246
Niles, MI	73	GM/SRT	6	Taxi	3,333	20,000	14	.139	1.41	145,000
Rochester, NY	81	GM/OAB Integ.	26	Bus/Van	3,077	80,000	16	.213	--	485,000
Grand Rapids, MI	100	TM/OAM	11	Bus/Van	3,636	40,000	20	.20	2.85	195,550
Syracuse, NY	104	TM/OAB	6	Bus	3,667	22,000	11	.125	1.29	197,000
Cuyahoga Co., OH	121	TM/OAB SRT	64	Bus/Taxi Van	1,328	85,000	10	.09	1.73	890,000

(Source: SYSTAN)

COST OF MAINTENANCE BY TYPE

(Ann Arbor, 7/75 to 3/76)

Type of Maintenance	Dollars/Vehicle-Mile	
	Vans - 51	Buses - 42
Scheduled	.0159	.0211
Unscheduled	.0338	.0441
Accident	.0038	.0182
Vehicle Improvements	.0023	.0138*
Road Call	.0038	.0060
No Cause	.0001	.0004
Total	.0597	.1036
Vehicle-Miles	816,081	591,405

(Source: Neumann, Lance A., Reference 67)

(D) The Models and Their Makers

Automobiles, vans and conventional buses have traditionally had large markets for uses other than demand-responsive transportation, and these industries have matured to the point where a small number of manufacturers produce vehicles with a proven reputation for reliability. The market for small buses has expanded only during the past few years, with many new manufacturers entering the market with new or adapted vehicles.

This recent emergence has quickly multiplied the number of small vehicle alternatives, making the vehicle selection process difficult. (Refer to SCRAPS Section 1.1 for vehicle specification characteristics and a list of vehicle suppliers.) While it is likely that the number of manufacturers will eventually stabilize, operators today face the risk of transacting with manufacturers who have not proven their performance capabilities. Poor vehicle performance can completely stymie operations; after facing initial procurement delays and problems, some frustrated operators have found themselves replacing unreliable vehicles after only a few years of use (Reference 238). Experience shows small vehicle durability to be less than adequate, falling far short of the heavier-duty conventional bus track record. Two reports have attempted to evaluate the multitude of small transit vehicle models available (References 234 and 240). Unfortunately, no national rating or consensus regarding the superiority or inferiority of different vehicles has developed. Operators contemplating purchasing a specific vehicle should therefore contact past and existing users before making any commitments.

1.1
Vehicle
Characteristics

(E) Obtaining Vehicles and Equipment

Traditionally, demand-responsive transit vehicles have been purchased in small orders, with only one or two vehicles in any single procurement. It is possible that combining purchases with other operators can save costs and eliminate complex specification and bid duplication. Procurement options include:

(i) Purchasing. Purchasing is the common method of obtaining vehicles and equipment, and the most economical in the long run if the service is considered permanent. If the service is experimental or the initial capital budget and prior operating experience are limited, short-term arrangements may be preferred.

(ii) Leasing. Leasing should be considered (where not prohibited) if:

- Funds available to finance the new project are limited.
- Ownership is not considered an advantage.
- The cost of leasing is lower than the cost of purchase. Obtain estimates of rental costs for equipment. Contact local vehicle and equipment suppliers for comparative pricing schedules.
- The project is not implemented on a permanent basis or start-up time is limited. It is better to lease or borrow vehicles for interim operation than to purchase equipment which does not meet a system's needs.
- The lease acts as a hedge against inflation (money is recovered sooner under leasing and, therefore, is available more quickly for reinvestment).
- Accounting work is less onerous than the recordkeeping required for owned vehicles and equipment.
- Protection against technical obsolescence is required. (Reference 4)

However, leasing arrangements may be limited to automobiles, unmodified vans or a small variety of buses, as most demand-responsive equipment is built to order for a fairly limited purchase market.

(iii) Existing Fleet. Existing operators may be able to provide all or part of the required vehicle fleet. Supplemental purchase and/or lease arrangements should be coordinated with the existing operator's stock. Thus, if new vehicles are to be obtained under a full service leasing contract, arrange maintenance licensing and insurance coverage for all vehicles.

(F) Vehicle and Equipment Specifications

Specifications set a framework for informed and rational hardware decisions by providing detailed and objective listings of the dimensions and features of vehicles and equipment. Operators using public funds will probably be required to issue detailed specifications and then purchase from the lowest bidder. If federal capital grants are to be used to pay a portion of the equipment costs, these specifications will need to be approved by UMTA.

3.2.8

Take advantage of qualified professional or technical assistance available from experienced radio equipment and small vehicle operators or consultants. Experience shows that carefully developed and enforced specifications can result in highly-reliable equipment purchased at relatively low cost. Lack of sufficient attention to these issues has frequently resulted in unsuitable hardware selection and operating nightmares (Reference 42). Look at the types of equipment, operating experience, and costs in relation to the proposed system. Remember: all systems are not alike. Equipment tailored to meet a system's needs can increase efficiency of operating and customer comfort (Reference 40). In general, if specifications vary greatly from existing equipment, the cost will be higher. Refer to SCRAPS Section 1.1 for different types of specifications and sample vehicle specification sheets. Based on the local performance and service criteria listed in the samples, draw up specification sheets for each piece of equipment that will be needed for the selected system.

1.1
Vehicle
Specification
Sheets

3.2.9 Design Communication System

Demand-responsive communication systems provide the necessary links between the (1) customer and the control center, and (2) the control center and the vehicles. The user/control center connection allows users to request paratransit service; the control center/vehicle system link then determines the status of vehicles and dispatches appropriate vehicles to serve passengers. This chain of services also uses an intermediate communication link to internally process and schedule the customer requests.

(A) Estimate Communication Requirements

(i) Identify Constraints. The Federal Communications Commission (FCC) has established numerous regulations concerning radio usage. The primary constraint expended by DRT radio use is the scarcity or nonavailability of channels. Some frequency and channel rationing has been instituted in order to provide the maximum benefit to the greatest number of people. Generally, preference is given to community services (police, fire, etc.), but one way to increase the availability of radio channels is to increase the amount of frequency-sharing or "pooling" with existing police, fire, taxi or other community radio broadcasters in an area. Increasing the range and more efficient usage of frequencies will help open the door for new DRT services, as well as take care of the mushrooming existing services. (Reference 243).

"Dead spots" typically caused by topographic or structural obstructions can restrict the areas where vehicles can send or receive communication. Identify the extent of these areas within the service boundaries. Consider moving or increasing the height of the base

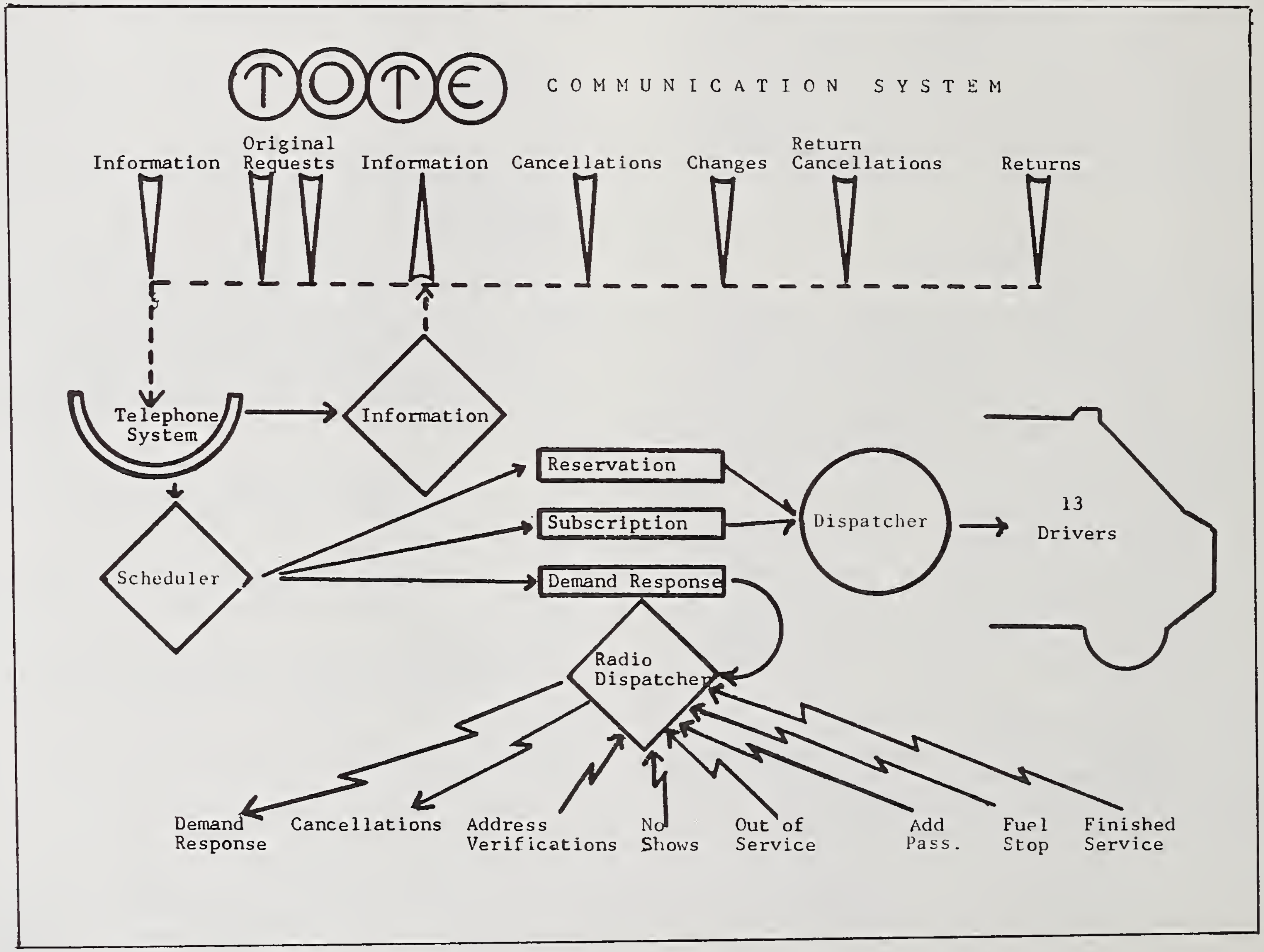
FEDERAL COMMUNICATIONS COMMISSION REGULATIONS

By authority of the Communications Act of 1934, as amended, the Federal Communications Commission (FCC) regulates:

- Allocation of portions of the radio spectrum to different types of broadcast services.
- Assignment of channels, frequencies, power, operating time, and call letters. Radio frequencies are assigned a three-letter and a three-digit code called "call numbers." Dispatchers must sign on and off the air with this radio identification code and state the call numbers every fifteen minutes while on the air.
- Issuance and renewal of radio broadcasting licenses. Radio frequencies may only be used for purposes specified in the license.
- Licensing of radio equipment operators. Broadcasting obscene, indecent or profane language is prohibited, and can be cause for revoking the system's license.

Any intrastate communication regulation comes under the authority of state utility commissions. Section 2.2.4(A) delves into additional state and local restrictions.

(Source: FCC, Reference 243)



(Source: St. Petersburg, Reference 126)

station antenna if these areas are large or will interfere with service.

(ii) Estimate Volume of Calls. Review Section 3.2.5 and allocate the estimated demand according to the customer access mode (e.g., immediate, access, subscription). These estimates will vary depending on the type of services offered, local conditions, and the type of riders anticipated (e.g., peak many-to-one service will have high subscription rates).

In highly-personalized immediate and advance request service, the call and dispatch requirements will approximately match the anticipated demands. In Rochester, New York's immediate-response service, the number of calls was 1.2 times the actual ridership, with the additional calls attributed to information and late vehicle inquiries.

Subscription service can be arranged with one initial control center contact, relieving a substantial portion of control center/user communication requirements. Standing orders could be kept on file to identify all scheduled subscription and advance-request travel service. Similarly, designated checkpoint(s), transfer station(s) and hailing options will mean raising the passenger rate in comparison to the call and dispatch rate. Those systems using a combination of customer access modes should proportionally allocate ridership according to the type of customer/control center link anticipated.

While more experience and statistical studies are needed to identify demand-responsive communication needs, the demise of the Santa Clara County system was due in part to a sizeable underestimate of the time required to handle each call and, consequently, the use of far fewer incoming lines and operators than were actually needed. Santa Clara County call-takers were initially expected to handle information, subscription, and immediate service calls within 90 seconds per call; although no exact figures are available, information and subscription requests will take much longer than this to process. During start-up, inexperienced reservationists may also need to consult maps, schedules and guides, requiring more time than in a mature system. The call-handling times reported by established systems range from about 40 seconds to three minutes (20 to 100 calls per hour), with the experienced operators in Regina, Saskatchewan handling as many as 100 calls per hour.

The experience in Santa Clara County and that of other systems suggests providing a safety margin in designing the communications system by providing more equipment than initial estimates indicate is necessary. Perhaps the telephone staff might be augmented with design and administrative personnel during the early stages of operation, when more calls will be received and take longer to handle. This can avert initial patron frustration and criticism of the service, as well as permit a quick response to expansion needs.

(B) Customer/Control Center Link

Telephone systems allow users to contact the control center for service or information. Demand-responsive

D 3.2.5 Detailed Demand Estimation

systems normally rely on regular business line telephone services. Some services have also instituted direct-dial "hotlines," permitting customers or controllers to automatically make contact with no dialing required. These convenient direct lines are typically placed at locations where many passengers are likely to board a DRT vehicle, such as shopping or other major activity centers and transfer stations.

Telephone-answering equipment usually consists of a simple telephone having one or more lines with calls arriving randomly. Separate telephone lines can be installed for supervisory and administrative use. As there will probably be times when the number of incoming calls exceeds the number of telephone operators available, more sophisticated equipment will avoid having customers wait for longer periods before their calls are answered. Equipment options are listed in the facing exhibit.

> Busy telephone lines will discourage potential riders from calling again.

Independent "hold" mechanisms allow telephone operators to interrupt current calls to answer new incoming requests, increasing the time required to answer each call and lowering system productivity. Answering devices can be combined to automatically pick up on incoming calls, inform customers of delay in servicing requests, and arrange calls in sequential order, thus permitting the telephone operator to answer calls which have been "holding" the longest.

On nights or weekends when the control center is closed, or for small systems unable to afford telephone operators, magnetic tape-recording equipment can be used to instruct callers to provide the required trip request

COMMUNICATION EQUIPMENT OPTIONS AND WORKSHEET

Item	Application, Installation Guidance	Unit Cost ($)	Number of Units	Total Cost ($)	Supplier	Delivery Date	Comments
<u>TELEPHONE EQUIPMENT</u>							
- Regular, private	Most common						
- Direct dial	Convenient, immediate access; locate at transfer & activity sites						
- Separate numbers/ extensions	Information or administrative lines						
<u>ANSWERING EQUIPMENT</u>							
- Headphones	Frees hands for recording caller information						
- Hold buttons	Manual answering & "holding" ability						
- Illuminated buttons	Visually shows incoming, held and busy lines						
- Automatic pick-up	Automatically answered within specified amount of time						
- Tape	Records basic service info; musak						
- Automatic Cut-Off Exclusion	Disconnect extension telephones from lines						
- Linear	Records time answered and length of call						
<u>BASIC RADIO EQUIPMENT*</u>							
Control Center							
- Base transmitter	Low power=desk top High oower=wall or floor						
- Base receiver	Desk top; may be housed with transmitter						
- Base antenna	Control ctr. or elevated building roof, hill, communications tower						
Vehicle:							
- Mobile transmitter	Speaker on dashboard or steering column						
- Mobile receiver	Insulated cabinent under driver seat						
- Mobile antenna	Mount to avoid clearance or damage problems						

(Source: SYSTAN)

*Sample two-way radio specification included in SCRAPS Section 3

Free Telephone Service for Teltran is spotted at several downtown Ann Arbor locations.

(Source: TSC, Reference 19)

ACCESSORY COMMUNICATION EQUIPMENT OPTIONS & WORKSHEET

Item	Unit Cost ($)	Number of Units	Total Cost ($)	Supplier	Delivery Date	Comments
Radio Equipment:						
- Microphone/speakers						
- Automatic station identifier						
- Automatic frequency control						
- Repeater base transmitter and receiver						
- Noise/tone squelch						
- Footswitch control						
- Handset control						
Digital Equipment:						
- Microprocessor						
- Printer control terminal						
- Monitor teleprinter						
- Mobile teleprinter/CRT						

(Source: SYSTAN)

information (name, origin, destination, desired time of departure, etc.). These highly cost-effective devices are particularly well suited for advance notice access (e.g., 24 hour) services, permitting a single dispatcher to replay the tape and assemble requests into tours the following day.

Contact the telephone company for local policies on tape-recording equipment installations, as some companies have restrictions on the type of attachments permitted.

For additional advance request user/control center systems, refer to SCRAPS Section 3.1.

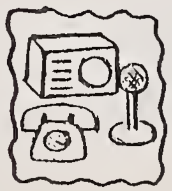
(C) Customer/Vehicle Link

Limited potential exists for user/vehicle radio links in very small systems (less than three or four vehicles). This arrangement would not be appropriate for large systems. A user/vehicle radio link allows users to contact the vehicle directly to request service and permits drivers to establish their own tours. Even under low demand density conditions (as in Mansfield, Ohio's one-bus route deviation service), radio channels can be busy most of the time, making it difficult for users to contact the vehicle.

(D) Internal Control Center Communications

Efficient internal information flow is important for maintaining high levels of service, especially in larger systems where incoming service request, scheduling and/or dispatching functions are handled separately.

Designers of integrated services should review fixed-route and demand-responsive schedules in designing and coordinating



3.1
Customer/Control Center Link

their communication system. Review Section 3.2.6 and refine timing, scheduling and coordination procedures. At this point, a major investment in cooperative effort may result in higher returns than an investment in sophisticated hardware.

(E) Control Center/Vehicle Link

DRT operations control can be greatly enhanced with on-board communication equipment, permitting verbal interaction with the drivers. While advance scheduling or subscription services may allow drivers to receive their tour instructions at the start of their runs, some communication link is still desirable for dealing with such abnormal occurrences as passenger no-shows, cancellations, vehicle breakdowns, and delays.

On-board systems normally use two-way radio voice communication, although a few demand-responsive bus and taxi systems have recently installed digital equipment.

One alternative to on-board devices particularly suitable for many-to-one service (with terminal located at the activity site) or route or point deviation service (with terminals located at ends of routes) is to connect output terminals to the control center via direct-dial or regular telephone lines. In Calgary, Alberta's many-to-one DAB service, drivers receive pick-up and drop-off instructions from transfer point terminals, and then continue operating until returning to the transfer station. Refer to SCRAPS Section 3 for some imaginative control center/vehicle communication examples.

(i) Radio Systems. The effective range of radio communication depends on the transmitter power output (RF amplifier power in watts), type of modulation (AM or FM), operating frequency, receiver sensitivity, antenna elevation, base station location, and area topography. Good terrain and antenna elevation well above any intervening obstructions can produce clear control center/vehicle communications within a radius of ten to thirty miles with ordinary equipment (Reference 4).

Estimate one mobile radio unit per vehicle. The number of channel assignments depends on the dispatching demands and the radio links. Generally, a radio channel using two-way voice transmissions can support approximately 125 trips per hour (Reference 151). One or two frequency simplex model rates are lower, requiring more channels to meet the same demand.

If service is to be integrated, line-haul vehicles can also be equipped with mobile voice units. This will require additional channels and multiple frequency capabilities. St. Bernard Parish, Louisiana attempted to coordinate and share radio space, then discovered that federal law required them to use one frequency to contact taxis and another to receive information from feeder bus drivers. Since radio spectrum space is extremely limited, it will probably be difficult to obtain more than five channels for any one system. Small systems may not be affected by this constraint; however, larger systems may want to consider digital data systems which can extend message capacities of about four channels to the equivalent of approximately twelve (Reference 151).

3.2.6
Design
Tradeoffs

3.2
Control Center
to Vehicle Link

(ii) Digital Systems. While digital data transmission has grown in recent years, it appears to be applicable only to large demand-responsive system operations, as demonstrated in Rochester, New York and Ann Arbor, Michigan. In these systems, a base station microprocessor converts coded tour messages into digital data messages; on-board terminals then receive and convert radio messages into printed or visual listings for the driver.

Digital systems are approximately five times faster and more accurate than voice communications. They can automatically record permanent records, increase passenger safety (as the driver does not need to remove hands from the steering wheel to receive instructions), and may be more cost-effective than adding radio channels and personnel in large systems. These benefits must be balanced, however, against the higher purchasing and maintenance costs and the additional staff training required. Radio voice communication capabilities are also generally maintained to allow drivers to relay messages to the control center and to retain as a back-up system.

Therefore, if high-volume demands are anticipated, start with a basic two-way radio system. As the service expands, digital equipment can be introduced and phased in to attain higher productivity levels. It may also be advantageous to consider using advanced computer dispatching technology in conjunction with digital transmissions, thus opening up other data management possibilities.

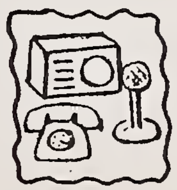
At the far end of the spectrum of devices linking vehicles with the control center are automatic vehicle monitoring (AVM) systems for continual automatic reporting of vehicle position and performance data. These complex technological systems may have future potential for improving service, lowering costs, and increasing security in large integrated systems. However, they are not currently appropriate for the smaller scale of the majority of DRT systems. SCRAPS Section 3.3 contains additional information on AVM systems.

(F) Analyze Cost/Performance Tradeoffs

(i) Costs. Telephone equipment is generally leased from local telephone companies. The price and features may be limited by the options locally available. Existing information shows costs ranging from a base monthly service charge up to about $2,000 for Los Angeles' taxicab automatic call distribution system.

Radio systems can vary tremendously depending on the options, models, and quality selected. The cost of basic control room equipment and stationary antenna ranges from $2,500 to $6,000, and has an expected life of about ten years. Previous experiences with mobile voice equipment show costs varying from $500 to $1,500, with a ten-year useful life reflected in the higher-priced equipment. However, transit operators recommend a minimum of $1,000 expenditure per mobile unit for a relatively reliable, sophisticated, rugged and quiet system. While less expensive equipment in the $500-$800 range is extensively used by the taxi industry, its low reliability and poor transmission quality is well documented. In other words, you can expect to get what you pay for.

Although the following cost ranges are based on relatively few sophisticated systems' operating experience, larger systems contemplating digital apparatus can expect to pay $10,000-$20,000 for control center equipment and about $3,000 to $10,000 per vehicle, in addition



3.3
Automatic
Vehicle Monitoring

TELEPHONE SYSTEM COSTS

FOR KANSAS CITY, MISSOURI

ITEM	INSTALLATION	MONTHLY CHARGE
3-Business Lines	$ 114.00	$ 34.80
3 10-Button Telephones	153.00	36.75
2 Private Lines	57.20	36.50
5 Line Equipment	28.00	8.00
TOTALS:	$ 352.20	$116.05

(Source: KCMR Dial-A-Ride Study, Reference 34)

to the basic radio communication costs. SCRAPS Section 3 lists component costs for an elaborate radio and digital communication system.

(ii) Performance Criteria. Based on prior experience, there are two basic design considerations used in selecting demand-responsive communication equipment: flexibility and expandability. Each system should also consider:

RELIABILITY: Consider local external environmental factors, such as weather conditions, temperature ranges, pollution and sub-optimum or abusive operating conditions. Northern communities will want to find out if certain equipment has proven especially difficult to start or operate in cold weather. Check maintenance records for failure rate and ease of servicing equipment. Transistorized components generally score high in these areas. Obtain back-up communication equipment to avoid paralyzing the entire service with individual breakdowns.

STABILITY: Select similar component types to reduce installation, training and maintenance problems and costs. Bulk purchases can provide economies of scale. Back-up equipment can then be freely substituted throughout the system.

LOCATION: Consider where and how equipment will be mounted (vehicle movement and constant jostling will affect performance); design to absorb impacts. Other factors include ease of service, maintenance accessibility and safety. Foot- or knee-operated transmit switches and gooseneck microphones allow hands-free driver communication. Minimize vehicle clearance problems with low antennae.

PRIVACY: Consider passenger objections to hearing a continual barrage of dispatcher instructions, especially in the larger communication demand systems. Audio tone codes can be assigned to individual vehicles and superimposed on the transmission system, or telephone-style handsets can permit all drivers to have access to conversations without disturbing passengers.

(G) Identify Information Flow and Procedures

Based on the system's access mode and communication links, outline the function of the proposed system. Identify basic requirements for order cards, dispatcher and driver logs, and operating records.

(H) Prepare Equipment Specifications

Refer to Section 3.2. 8(E) for general guidelines and SCRAPS Section 3 for sample two-way radio specifications. Use the Basic Communication Equipment Options Worksheet included in this section.

PLEASE HELP OUR DISPATCHER KEEP COOL

* If you can, give us half an hour or more advance notice when you want to ride.
* Leave your porch light on until the vehicle arrives.
* For your own safety, nighttime Dial-a-Ride will serve telephone requests only. No hail stops or walk-ons.

--Ann Arbor Dial-a-Ride

3.2.8(E) Obtaining Vehicles & Equipment

3.0 Two-Way Radio System Exhibit

3.2.10 Design Scheduling and Dispatching System

The control center of any system follows certain standard procedures to coordinate the demand for service with its vehicles and drivers. However, individual system requirements will vary depending on the access mode, service option, system configuration and demand for the service.

Much of the material in this section was first assembled in the Canadian DAR Manual (Reference 4).

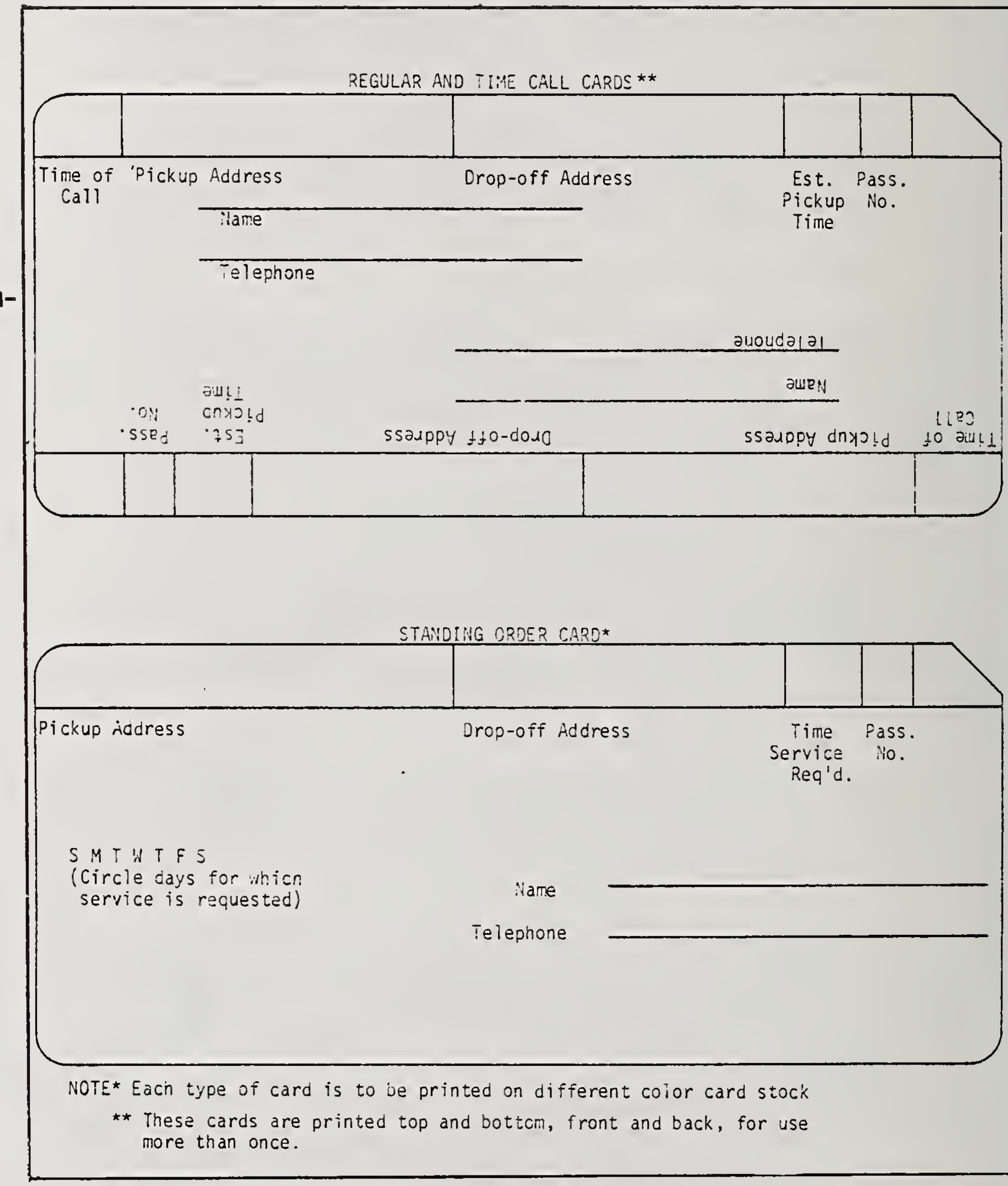
(A) These basic scheduling and dispatching tasks will be performed at the control centers:

- Receiving and recording user requests for immediate, advance or subscription service.
- Organizing service requests into vehicle tours.
- Assigning service requests to vehicle tours by communicating with respective drivers.
- Handling late calls and inserting these into appropriate existing tours.
- Monitoring vehicle location, scheduling and status to match demand and service requirements.
- Coordinating transfers to another mode of transit.

(B) Data requirements to fulfill these tasks fall into three categories:

<u>(i) User Information</u> (to be filled in on an order card)

- Address and destination of the user.
- Number of travelers represented by the call.
- Time of call.



(Source: KCMR Dial-A-Ride Study, Reference 34)

- Requested date and time of pick-up (at origin) or arrival (at destination).

(ii) Vehicle Status Information

- Location and direction of vehicle.
- Number of passengers on board.
- Destination of passengers.
- Driver shift change or break time.

(iii) System Information

- Traffic flow status.
- Accidents or other emergencies
- Diversions due to road closings, etc.

(C) Dispatching procedure will follow one or more of these service types:

(i) Many-to-One. This service operates in one or more zones to and from a single main activity (or traffic generator, such as a transfer station). Each vehicle tour consists of two parts: (1) the outbound function (O-M) where passengers are picked up at the terminal point and delivered to their destinations scattered throughout the service area, and (2) the inbound function (M-O) where passengers are collected at various origins and delivered to a central location.

To minimize both waiting time and in-vehicle passenger travel time, the dispatcher should arrange to:

- o Drop off riders before pick-ups begin, so that inbound passengers will not be taken on a longer ride than necessary.
- o Start outbound tour with closest destination to terminal and end at farthest point away; conversely, inbound tour should begin at farthest point and finish at the closest location. Rule of thumb: passengers should always be traveling toward their destination.
- o In more circular tours, maintain a common direction so that the first pick-up inbound is the last drop-off outbound. This will equalize average travel time among all riders.

Outbound tours may not require dispatcher processing. Passengers may board buses bound for a particular zone giving the driver their desired destination. Driver enters addresses on his log sheet. After everyone is on board, the driver plans his route. A map serves as the driver's aid in route planning.

Inbound tours require control center processing. The scheduler/dispatcher should:

- o Obtain passenger service request listings from telephonist's log, advance requests, and subscription records. When trip requests are known ahead of time, as in subscription and advance-notice service, more efficient tours may be constructed than when tours are created incrementally in response to incoming requests. This would be especially true if customer requests are made for a specified time range rather than a single time, thus offering the scheduler greater flexibility in constructing tours. Aggregate calls according to desired pick-up time and origin zones. Assign addresses to a particular bus tour.

3.2.10

- Relay pick-up instructions to driver when bus is at transfer terminal or in holding position. Information may be hand-carried if control center is adjacent to terminal, transmitted by radio, or procured as a print-out by digital systems.

- In most common radio systems, drivers then enter addresses onto log sheet (sample attached). Advance and subscription requests can be given to each driver when shift begins, thereby easing the dispatcher's load.

- Depending on service demands, either the driver or the dispatcher may sequence the stops and plan the route.

- The dispatcher should radio last-minute requests to the driver, if they can be accommodated without disrupting the tour schedule. Try not to force passengers to ride too long by sending a bus "a little out of its way" for one passenger (who called in last). Never make a bus backtrack once it has passed a pick-up point with passengers on board.

(ii) Many-to-Few. Many-to-few service is basically a variation of many-to-one service, where more than one main activity center is being served. There are four routing configurations for a many-to-few operation:

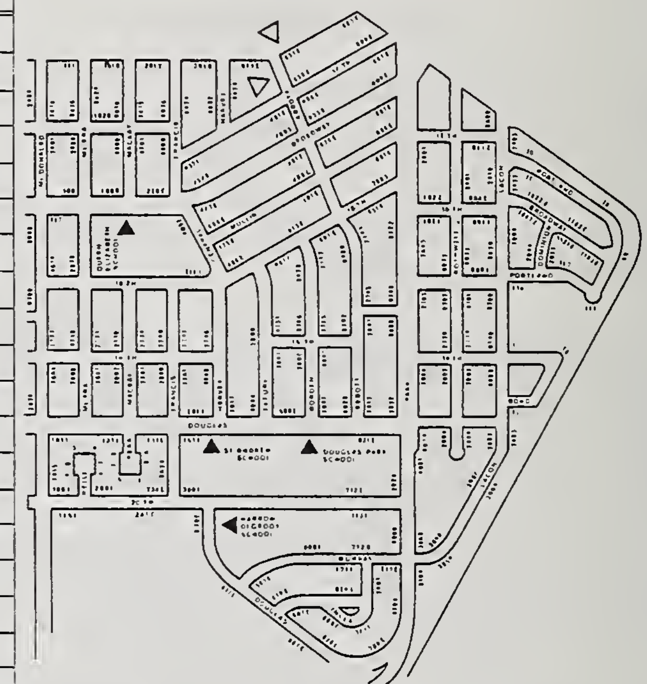
(1) M-O and O-M with transfers at the nodes and transfer point arrivals synchronized;
(2) M-F with several activity nodes served on each tour without a transfer;

REGINA TRANSIT SYSTEM
TELEBUS PROJECT—OPERATOR'S TRIP RECORD

TELEBUS OPERATOR ______ BUS NO ______ DATE ______

CONNECTING BUS ROUTE ______ BUS NO ______ ARRIVAL TIME ______

MILEAGE OUT	
SUBSCRIBER'S ADDRESS	CODE



CODES: NS - NO SHOWS   LC - LATE CALL (RADIO)   S - FLAG STOP
X - PICKUPS   O - DISCHARGES   SEX - M/F

DISCHARGES			

(Source: Canadian Dial-A-Bus Manual, Reference 4)

(3) M-O with service to a secondary or tertiary node on request; and
(4) M-O with service to nodes by multiple routes serving a common zone.

For this type of service, the aggregation of calls and the communication arrangement in a many-to-one operation still apply. In this system, however, the dispatching tasks becomes more complex. To assist the dispatcher in keeping track of vehicle locations and vehicle status if there are more than five vehicles, a status indicator (such as a map with magnets) might be required.

(iii) Many-to-Many. Routings, pick-up and drop-off points are randomly distributed throughout the service area, making the many-to-many dispatching task more complex. Since little queueing can be done ahead of time (unless advance notice or subscription service is desired), dispatchers are responsible for identifying vehicle location and re-routing vehicles at every stop, thus increasing communication demands. Alternatively, a longer wait time for the first caller will allow time for other requests to come in which might fit with that request, thus increasing system productivity. Aids such as a map board, markers for vehicles, markers for pick-ups and drop-offs are recommended.

For each incoming demand, an order card is filled out; the scheduler then sorts request cards according to sequence. A matrix rack with slots for each vehicle in the system may be useful. Leaving blank spaces, the scheduler can later insert new request slips in an order chosen to create the most efficient tours. As vehicles reach an address previously given by the dispatcher, the driver signals the dispatcher, who then relays the next pick-up address. Order cards are moved within the same column to identify specified vehicle drop-off locations.

Route and checkpoint deviations for pick-ups will demand control center processing. The dispatcher should identify route departure point and suggested vehicle loop tour. When deviating from route, vehicle must return to same departure point. Door-to-door service tours are more flexible between designated checkpoints and stops.

(v) Integrated. Scheduling/dispatching functions become increasingly complicated as fixed-route service places schedule constraints on the total system. Any of the above demand-responsive services may be integrated with other transit modes by synchronizing transfer station (or control points as in many-to-many service) arrival times. Schedule information, required travel time per demand-responsive tour, vehicle capacities, and increased communication time are necessary control center prerequisites for coordinating service. Locate and schedule transfer stops at ends of routes. Route end layovers can minimize passenger wait times and help system adhere to schedule.

Occasionally, dispatchers may need to instruct scheduled drivers to wait for a late-arriving DRT vehicle. As frequent delays can disrupt the entire system, however, schedulers may find they need to readjust their prerequisite inputs (e.g., estimated travel time).

(D) Match Scheduling/Dispatching System to Service Needs

Computers can be used in DRT operations for request, scheduling and vehicle dispatching in addition to data management functions, standard accounting, and bookkeeping tasks.

3.2.10

The scheduler/dispatcher uses a routing algorithm to assign service demands to vehicles. Two methods, the vector and the zonal, have been used:

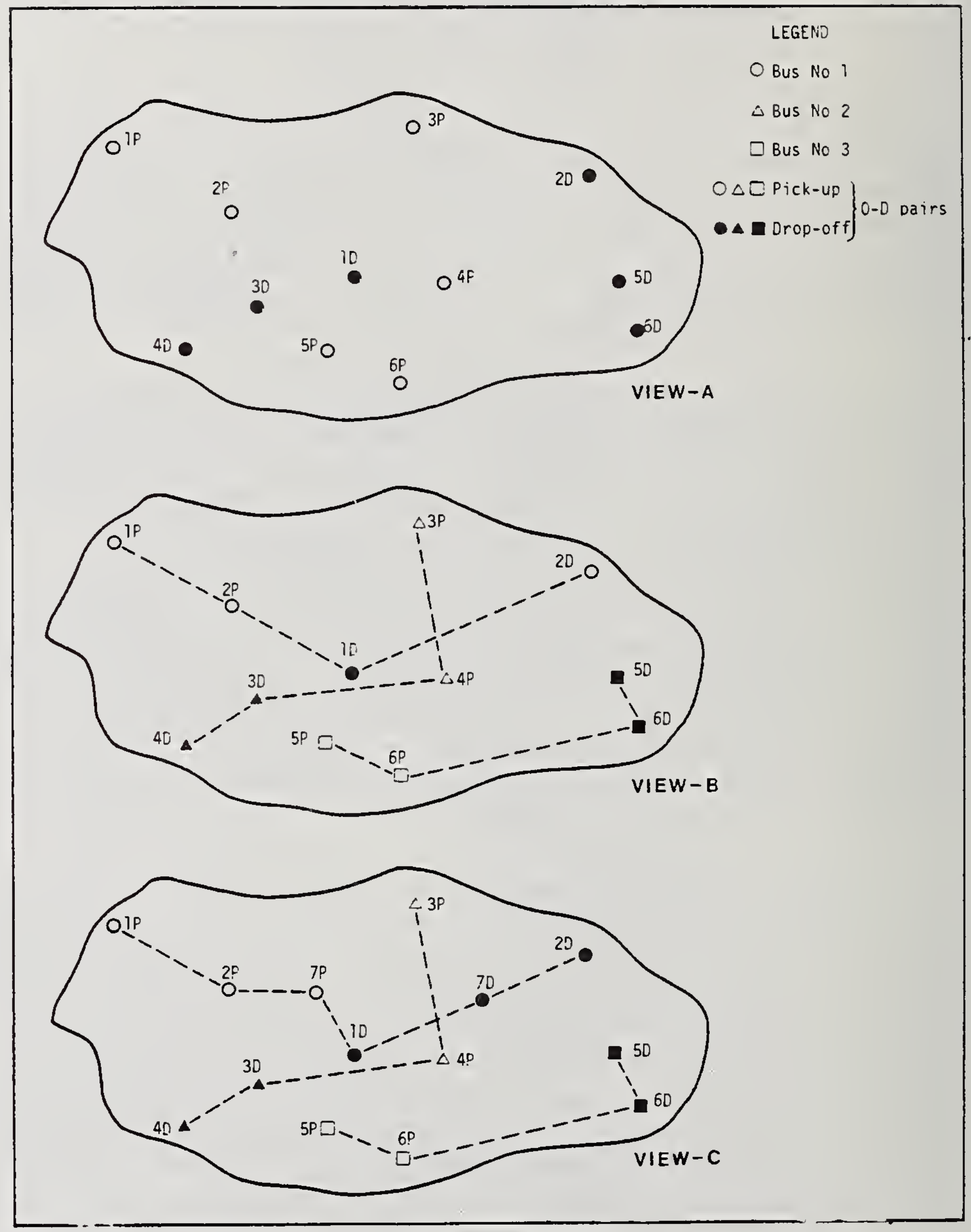
The vector principle--used in Batavia, New York, Columbia, Maryland and Haddonfield, New Jersey--links, as directly as possible, different pick-up points that are close together and that have compatible destination points within the service area. The scheduler combines links to form the vehicle tour (see facing exhibit). Drivers would only be notified of their next stop, as routes would be continously modified as new requests come in.

The zonal or control method used in Columbus, Ohio simplifies dispatching by decreasing the vehicle's degree of liberty over space and time. Grouping dispatch communication at predetermined control points allows the system to maintain required service standards at high demand.

The service area is divided into sectors or zones with a common intersection point. Zonal boundaries cut through control points, which are usually activity centers or transfer points (see next exhibit). Dispatching techniques are simplified and become similar to many-to-few operations. Zonal configurations usually experience longer passenger ride time. To compensate, increase frequency by establishing two-vehicle "circuits," one clockwise, the other counterclockwise (see exhibit on next page).

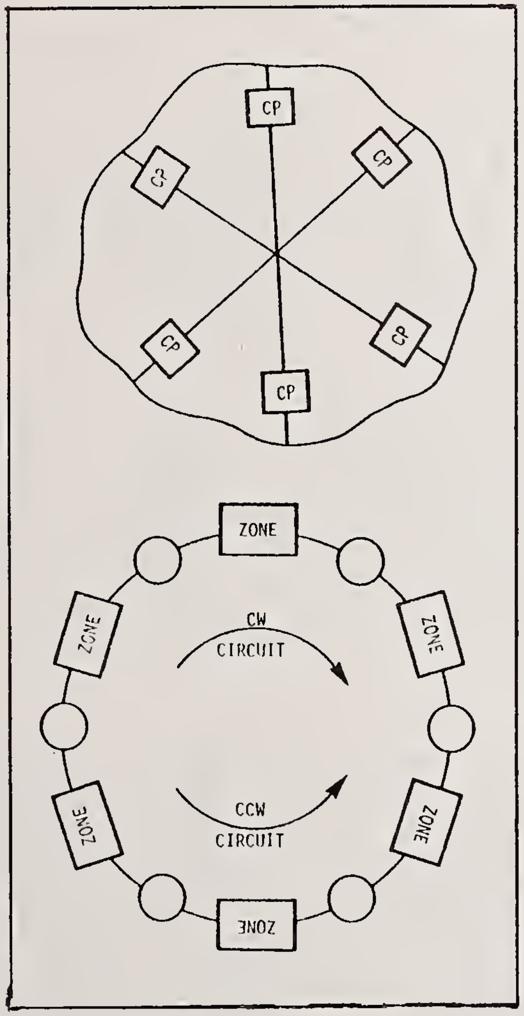
(iv) Route and Checkpoint Deviation. Route deviation is basically a variation of many-to-one: Outbound passenger drop-offs may not require dispatcher instructions; however, drivers should notify dispatcher of drop-off deviations for schedule control.

VECTOR METHOD FOR VEHICLE ROUTING



(Source: Canadian Dial-A-Bus Manual, Reference 4)

ZONAL/CONTROL POINT METHOD
FOR VEHICLE ROUTING



(Source: Canadian Dial-A-Bus Manual, Reference 4)

The overwhelming majority of existing demand-responsive systems do not use computers in scheduling and dispatching; only five of the 98 services in the survey reported such use. However, most existing systems are relatively small, and computerization is most appropriate in larger systems where computer usage would result in sizeable decreases in control room personnel requirements.

The small number of existing systems which have tried to computerize vehicle scheduling functions have reported mixed results, and the role of the computer in this function has been the subject of substantial debate. In general, the academic community has more faith in the ultimate role of the computer for large area dispatching than DAB system operators, although both recognize the value of the computer for high-speed data storage, processing and retrieval.

The relative attractiveness of a computerized scheduling and dispatching system clearly increases with the size and complexity of the system. Several design options are possible in computerizing the vehicle scheduling and dispatching functions, including:

- Tour processing, in which tours are organized and stored manually in the computer to simplify the recordkeeping and scheduling process (e.g., Ann Arbor, Michigan).

- Computer-assisted scheduling, in which operators enter requests in the computer system and the dispatcher makes a selection among a limited number of alternatives presented by the computer (e.g., Santa Clara County, California).

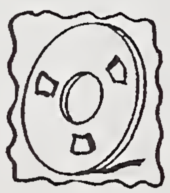
- o Fully-automated scheduling, in which the computer uses an internal algorithm to schedule and dispatch vehicles in response to travel requests (e.g., Rochester , New York).

Viewed on a scale of increasing complexity, six different "generations" of dispatching systems can be identified:

1 Manual
2 Manual with markers or maps
3 Computer aided
4 Computer decisions with manual override
5 Fully automated
6 Fully automated Integrated controls

The breakpoint for supplementing manual control with computer control is thought to be 10 to 15 vehicles. Some analysts have placed the number of vehicles that can be handled manually as high as 20 or, alternatively, when peak capacity exceeds 200 demands/hour (Reference 4). Above these thresholds, passenger trip information requirements become extremely cumbersome. The facing exhibit identifies and correlates the degree of automated dispatching systems with a range of population and fleet sizes.

See SCRAPS Section 2.1 for a further discussion of each generation, functional computer applications, and a listing of those systems currently using computer assistance.



2.1
Degrees of
Automation

TYPICAL VARIATIONS IN DAB SERVICE ASSUMING MANY-TO-MANY OPERATIONS

Configuration	A	B	C	D
Population of Service Area	Less than 50,000 (1-20 buses)	50,000 - 250,000 (15-50 buses)	250,000 - 750,000 (40-200 buses)	More than 750,000 (200 buses up)
Type of Control	Manual	Manual with Some Computer Assistance	Semi-Automatic	Fully Automatic
Customer Communication	- telephone request to central dispatcher in peak period - radio-telephone to a driver-dispatcher in off-peak	- telephone request to central dispatcher - during peak periods supply clerical assistance to answer telephones - radio-telephone to driver dispatcher in evening or recorded for delayed playback	- telephone request to telephone operators - request key punched directly to computer	- telephone request to telephone operators with requests key punched directly into computer, or - telephone request direct to computer by means of automatic number identification computer of the telephone company
Dispatching	- dispatcher plans tour - voice radio communication between driver and dispatcher - driver plans route	- voice radio communication between driver & dispatcher - dispatcher plans tours with some computer assistance	- computer plans tours - driver-computer communication via digital & teletype equipment - small monitoring computer - computer-operated CRT's for central dispatcher	- driver-computer digital communication via mobile teleprinter equipment and status encoder - full-sized duplex scheduling computer system - possibly AVM but not absolutely essential
Record Keeping	- permanent requests on daily subscriber files. Bookings typed daily by secretary - casual requests kept on dispatcher's log - driver lists addresses on separate trip sheets	- time shared computer for permanent requests. Daily trips printed by computer from central file - casual requests kept on dispatcher's log - driver keeps addresses on individual trip sheets	- permanent requests fed directly to monitoring computer - casual requests kept in computer memory - address given to driver via printing device on receiving equipment in vehicle	- all requests, permanent and casual, fed directly to scheduling computer

(Source: Canadian Dial-A-Bus Manual, Reference 4)

3.2.11 Develop Detailed Cost and Revenue Estimates

Many of the decisions made in the design stage will permit more precise estimates of both costs and revenues. These estimates will serve as the basis for preparation of the budget estimate at the close of the design stage (see Section 3.2.16).

(A) Cost Estimates

The design cost estimate should be a careful piece of work that is based on all available information about the proposed new demand-responsive transportation service. The designer has considerable guidance to help him prepare a reliable estimate of the capital and operating costs. Policy decisions at the conclusion of the planning stage will have set financial limits for both capital assets and operating subsidy. Configuration design will have established the vehicle size, the number of vehicles, the tour times, operating periods and dispatching modes. Demand-estimates and fare policy will support revenue estimates. The first step in the cost estimate is to assemble the available information and to check it for completeness and consistency. The exhibit lists some of the capital and operating costs to consider. The designer should assure himself that he has adequate information to make these estimates.

The next step is to identify the trade offs that are available between capital and operating costs. The designer should decide which assets must be purchased and which assets can be secured through leasing, contract and other means. Most capital assets can be secured by lease if local, state and federal regulations will allow it. For example, a paratransit operator who needs seven minibuses that cost $35,000 each may wish to consider the relative merits of purchase and lease options. If the buses have a

MODULAR COST MODEL FOR DIAL-A-BUS

COST MODULES	CAPITAL	OPERATING
VEHICLE COSTS	. vehicles . fare collection equipment	. fuel and oil . maintenance and servicing . tire rental . vehicle rental
OPERATIONAL LABOUR COSTS		. dispatchers . drivers . maintenance . clerical
COMMUNICATION COSTS	. voice radio equipment . printer radio equipment . digital data equipment . automatic vehicle monitoring	. maintenance contracts
SUPERVISORY COSTS	. fare collection equipment . small computer . office equipment . dispatching aids	. computer rental . office equipment . office supplies . tickets . uniforms . data terminals
PROMOTION COSTS		. advertising . public relations
MISCELLANEOUS	. land . buildings . machinery, equipment	. system administration . licenses . taxes . legal fees . debt charges, interests

(Source: Canadian Dial-A-Bus Manual, Reference 4)

3.2.16
Implementation
Budget

3.2.11

life expectancy of ten years, a salvage value of $1,000 each, and if funds are available at 10% interest, then the equivalent annual cost of the capital investment is:

$35,000 X 7 buses X capital recovery factor (10% for 10 years) - 1000 X 7 buses X sinking fund factor (10%, 10 years)

= $35,000 X 7 X 0.16275 - 1000 X 7 X 0.6275

= $39,434.50 per year.

Capital recovery factors and present worth factors are available from interest tables, such as the exhibit. If the operator could lease the buses for $6,000 per year each, then his lease cost would be:

7 X $6,000 = $42,000 per year.

In this instance, with money available at 10% interest, it would be cheaper to purchase the buses. However, this is not the whole story. The operator may be able to secure an 80% federal capital grant to purchase the buses. This would reduce the local capital requirement to:

(0.2) X $35,000 X 7 X 0.16275 - 1000 X 7 X 0.06275

= $7,535.50 per year,

which is just over the lease cost for a single bus. The above calculation assumes that federal grant money is free. This is not quite true. To obtain a federal grant, a state or community may have to forego a prospective grant for another purpose; this is particularly true in the case of formula funds and transit projects that use highway funds. Therefore, some interest rate should be associated with the federal funds. Federal grant acceptance brings with it the provisions of the UMTA Act, e.g., Section 13 (c) and charter restrictions.

SAMPLE INTEREST TABLE - 10%

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf′	Present Worth Factor pwf′	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.100	0.9091	1.00000	1.10000	1.000	0.909	1
2	1.210	0.8264	0.47619	0.57619	2.100	1.736	2
3	1.331	0.7513	0.30211	0.40211	3.310	2.487	3
4	1.464	0.6830	0.21547	0.31547	4.641	3.170	4
5	1.611	0.6209	0.16380	0.26380	6.105	3.791	5
6	1.772	0.5645	0.12961	0.22961	7.716	4.355	6
7	1.949	0.5132	0.10541	0.20541	9.487	4.868	7
8	2.144	0.4665	0.08744	0.18744	11.436	5.335	8
9	2.358	0.4241	0.07364	0.17364	13.579	5.759	9
10	2.594	0.3855	0.06275	0.16275	15.937	6.144	10
11	2.853	0.3505	0.05396	0.15396	18.531	6.495	11
12	3.138	0.3186	0.04676	0.14676	21.384	6.814	12
13	3.452	0.2897	0.04078	0.14078	24.523	7.103	13
14	3.797	0.2633	0.03575	0.13575	27.975	7.367	14
15	4.177	0.2394	0.03147	0.13147	31.772	7.606	15
16	4.595	0.2176	0.02782	0.12782	35.950	7.824	16
17	5.054	0.1978	0.02466	0.12466	40.545	8.022	17
18	5.560	0.1799	0.02193	0.12193	45.599	8.201	18
19	6.116	0.1635	0.01955	0.11955	51.159	8.365	19
20	6.727	0.1486	0.01746	0.11746	57.275	8.514	20
21	7.400	0.1351	0.01562	0.11562	64.002	8.649	21
22	8.140	0.1228	0.01401	0.11401	71.403	8.772	22
23	8.954	0.1117	0.01257	0.11257	79.543	8.883	23
24	9.850	0.1015	0.01130	0.11130	88.497	8.985	24
25	10.835	0.0923	0.01017	0.11017	98.347	9.077	25
26	11.918	0.0839	0.00916	0.10916	109.182	9.161	26
27	13.110	0.0763	0.00826	0.10826	121.100	9.237	27
28	14.421	0.0693	0.00745	0.10745	134.210	9.307	28
29	15.863	0.0630	0.00673	0.10673	148.631	9.370	29
30	17.449	0.0573	0.00608	0.10608	164.494	9.427	30
31	19.194	0.0521	0.00550	0.10550	181.943	9.479	31
32	21.114	0.0474	0.00497	0.10497	201.138	9.526	32
33	23.225	0.0431	0.00450	0.10450	222.252	9.569	33
34	25.548	0.0391	0.00407	0.10407	245.477	9.609	34
35	28.102	0.0356	0.00369	0.10369	271.024	9.644	35
40	45.259	0.0221	0.00226	0.10226	442.593	9.779	40
45	72.890	0.0137	0.00139	0.10139	718.905	9.863	45
50	117.391	0.0085	0.00086	0.10086	1163.909	9.915	50
55	189.059	0.0053	0.00053	0.10053	1880.591	9.947	55
60	304.482	0.0033	0.00033	0.10033	3034.816	9.967	60
65	490.371	0.0020	0.00020	0.10020	4893.707	9.980	65
70	789.747	0.0013	0.00013	0.10013	7887.470	9.987	70
75	1271.895	0.0008	0.00008	0.10008	12708.954	9.992	75
80	2048.400	0.0005	0.00005	0.10005	20474.002	9.995	80
85	3298.969	0.0003	0.00003	0.10003	32979.690	9.997	85
90	5313.023	0.0002	0.00002	0.10002	53120.226	9.998	90
95	8556.676	0.0001	0.00001	0.10001	85556.760	9.999	95
100	13780.612	0.0001	0.00001	0.10001	137796.123	9.999	100

i represents an interest rate per interest period.
n represents a number of interest periods.
P represents a present sum of money.
S represents a sum of money at the end of n periods from the present date that is equivalent to P with interest i.
R represents the end-of-period payment or receipt in a uniform series continuing for the coming n periods, the entire series equivalent to P at interest rate i.

(Source: Grant and Ireson, Principles of Engineering Economy)

These provisions are part of the operating cost associated with the federal grant option. The comparison between purchase and lease might be;

Purchase

A. Federal grant

$28,000 x 7 x 0.12329 (4% interest on federal funds)	=	$24,164.84
Local funds		
$7,000 x 7 x 0.16275 - 1000 x 7 x 0.06275=		7,535.50
Increased labor cost		4,327.00
Lost revenue		3,785.00
Equivalent annual cost	=	$39,812.34

B. Local Purchase

$35.000 x 7 x 0.16275 - 1000 x 7 x 0.06275=39,434.50

Lease

$6.000 x 7	=	$42,000.00

In this case, purchase with local funds appears to be the perferred option, because other costs outweigh the apparant advantage of the federal grant.

Lease-purchase decisions need to be made for:

Vehicles
Communication equipment
Fare collection equipment
Maintenance facilities
Dispatching/office facilities
Automatic equipment

In making lease-purchase, and internal contract decisions there are factors other than cost that should be considered. These include lease terms, schedule limitations, price escalation and service quality. Each factor should be weighed carefully when comparing it with expected money costs.

Two important factors contributing to the cost estimate are maintenance and administration. Vehicles can be maintained by an outside agency, either under contract or not. About one-third of the existing demand-responsive systems maintain their own vehicles; other purchase maintenance from another public transit agency or elsewhere. If vehicles are staff-maintained, maintenance costs are essentially fixed because labor is the principal maintenance cost, followed closely by facilities and inventories. Part and supply costs, while important, are small when compared with fixed costs of labor and facilities. Section 3.2.8 provides further guidance in choosing maintenance programs.

An administrative staff can be provided by the demand-responsive system; however, for small systems, the staff can be more advantageously provided by outsiders. The least expensive source of administrative services is another agency of local government. The marginal cost of adding the demand-responsive load to the existing agency is low, and may not be charged to the system. Attention should be paid to the skill and responsiveness of these services. Where no local administrative skills are available, some cities have elected to contract for outside management. Management firms can centralize finance, accounting, and personnel functions. They can use specialized skills for marketing and planning on a periodic basis without the cost of maintaining a permanent staff. Section 3.2.1 and 3.2.12 discuss operator capabilities in more detail.

3.2.8 (C) Maintenance Program
3.2.1 Selecting Technical Support
3.2.12 Selecting Operator

(i) Capital Costs. The capital costs estimate should be based on actual bids or estimates for all capital assets. Always get more than one bid. These bids may be based on detailed specifications, where such specifications are available. Otherwise bids on standard equipment can be secured.

DO NOT put yourself in the hands of a supplier who is only too happy to furnish specifications and perform analyses at no cost or obligation. This "FREE" help can be very costly.

Some factors to consider in estimating the principal capital and operating costs are listed in the exhibit. All of these costs need to be adjusted for local conditions (e.g., wages, fuel, rent, utilities and interest). Nearby operators will often provide useful cost, supplier and experience data.

Vehicles. Consider the number of back-up vehicles needed. This can be a major expense that will be influenced by maintenance policy and practice. For example, in-house maintenance may be scheduled for night time work so that back-up vehicles are needed only for breakdown emergencies. Contract maintenance may be limited to daytime operation so that vehicles are taken out of operation.

Lead times for vehicle procurement can be long (as long as 18 months) and should be checked. If advance procurement is required, great care should be taken to assure that the correct number of vehicles is purchased.

Telephone. Provide for adequate number of lines. Consider equipment for holding calls. Many customers are lost through busy signals; telephone service is not a major cost item.

CAPITAL COST CONSIDERATIONS

Telephone Equipment (usually not purchased, leased from local telephone companies - prices vary)

Installation costs, plus

Annual operating costs = monthly service charge x 12.

Monthly service charges can range from negligible base rate ($10-15/line) up to about $2,000 for automatic call distribution system.

Estimate approximately 1-2% of total operating costs.

Radio Equipment (if leasing, prices will vary, service and maintenance costs can be included in leasing contract)

Base Radio (transmitter & receiver)	$2500 - 6000
Base Antenna	$500
Mobile Radio (transmitter, receiver & antenna)	$500 - 1500/vehicle

Fareboxes	$250/vehicle

Digital Equipment

Base Station	$10,000 - 20,000
Mobile	$3000 - 10,000/vehicle

(Source: SYSTAN, based on data from Ann Arbor, Rochester, and DAVE Systems California installations)

Communication. Providing insufficient communication channels can be a costly mistake. It is often wise to allow a 50% contingency in the number of channels sought.

Automatic Equipment. The inital installation of automatic equipment is not consistent with the "go slowly" advice that is sprinkled throughout these guidelines. It is generally wise to operate demand-responsive systems manually before automatic equipment is considered.

Fare Collection. Once selected, fare collection equipment is relatively inflexible. It should be selected with care for a long operating life.

Maintenance Facilities and Equipment. A wide variety of different facility types and arrangements are available. Existing structures can be remodeled or a new structure can be built. A central location is important to minimize vehicle deadheading.

Dispatching Center and Office. Subject to communication constraints the dispatch/office center can be located anywhere. It need not be pretentious -- few customers will see it.

Capital costs are rising sharply. If the implementation date is far in the future, a substantial contingency should be added to the capital cost estimates to account for inflation.

(ii) Operating Costs. Operating costs should be based on unit costs that have been prepared for the actual operating environment and on the best available estimates of the quantities of each item required. The most important single factor in the operating cost estimate is the labor rate. The applicable rate must be determined with great care. Important items to consider include:

1. Labor affiliation: Labor affiliated with transit operations is generally more expensive than labor affiliated with taxi operations. However, cost is often not the criterion for determining labor affiliation. Institutional issues and jurisdictional battles often play key roles. If these matters have not been resolved, it may be wise to opt for the higher labor rate in the cost estimate. In some cases (e.g., Cleveland), special paratransit rates have been negotiated.

2. Union affiliation: The impact of union affiliation on labor rates is unclear. Union officials claim that it makes no difference. Limited experience suggests that union affiliation increases the rate for transit-based labor. Section 13(c) provisions have been interpreted as inviting paratransit workers to organize. An effective union agreement defines labor costs.

3. Part-time labor: Part-time labor is often cheaper and more flexible than full-time labor. However, part-time labor requires more administration than full-time labor. Nonetheless, on balance, part-time labor is sufficiently attractive to warrant careful investigation.

4. Volunteer labor: Volunteers are even more difficult to administer than part-time labor, but the price is right.

5. CETA labor: CETA workers have been helpful in some applications. However, their record is spotty. They also require extra administration.

Given good labor rate estimates, operator and dispatcher costs can be estimated from the operating schedule and the contemplated level of service. Other costs are more difficult to estimate.

Vehicle maintenance costs can vary from 8 to 20 percent of total operating costs. Annual maintenance costs per vehicle range from $1,360 (Gladwin, Michigan --three vans) to $85,000 (Cuyahoga County, Ohio-- sixty-four vans and buses). Some of this cost is discretionary with paratransit management. Actual costs will depend on:

-Vehicle type,
-Vehicle age,
-Uniformity of vehicle fleet,
-Maintenance policy,
-Maintenance orgainzation (in house, contract),
-Level of operation,
-Quality of drivers, and other factors.

Local transit and taxi operators can be helpful. Other fleet operators may have useful insights. Bids should be sought from potential maintenance contractors. These will probably be based on vehicle usage which can be estimated. Bids that are restricted to an hourly rate are not particularly useful. In-house maintenance costs can be estimated by structuring a staff and costing it at the best estimated maintenance rate. Parts and supplies do not generally exceed 25 percent of the labor cost.

Maintenance of communication and other equipment are not major cost items. Maintenance can be estimated at one to two percent of the annual operating cost.

Management and administrative costs are difficult to estimate because part or all may be provided by others. The activities to consider are:

-Supervision,
-Accounting,
-Personnel,
-Insurance,
-Utilities,
-Marketing,
-Clerical,
-Public relations, and
-Planning.

In small systems all of these activities can be performed by a single individual. In other systems, local agencies will provide many activities at no charge. In any situation, a contractor will undertake all or part of the assignment.

To provide the best cost estimate, it is wise to:

1. Seek at least two bids from potential contractors,

2. Negotiate with local government, transit and taxi agencies to see what services each will furnish and what fee each will charge, and

3. Make an independent cost estimate on the basis of a carefully developed staffing plan.

Compare the results of the three approaches. Formulate a plan for following one or a combination of the alternatives. Estimate the cost of the selected plan.

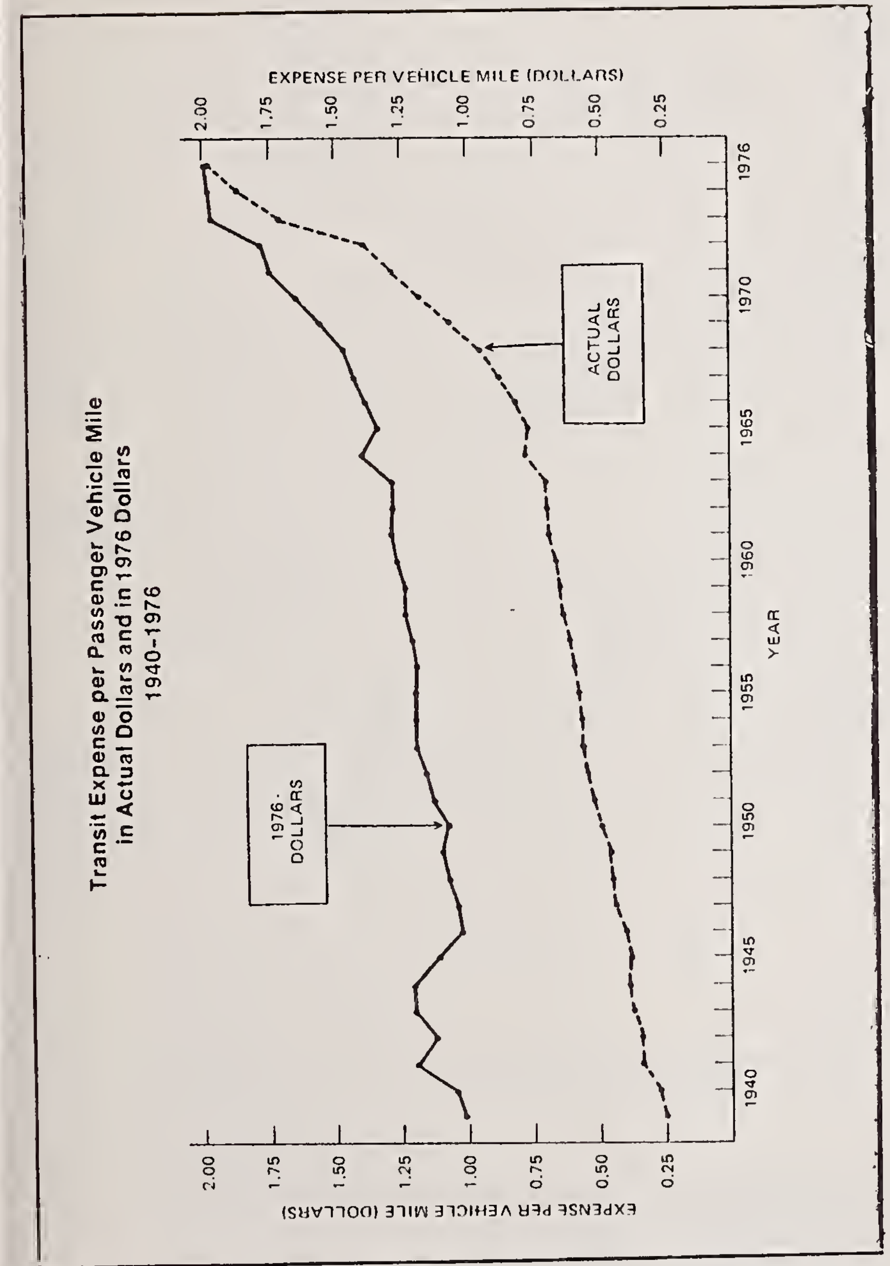
Once operating costs have been estimated, they need to be projected at least five years into the future. Costs will continue to rise. For estimates of later year costs, inflation factors will need to be used. The following exhibit illustrates the trend of cost per vehicle mile for the period from 1940 to 1976. This measure is not directly applicable to paratransit services, but it gives an indication of recent cost increases. To estimate future costs:

$$\text{Future year cost} = \text{1978 cost } (1.08)^{\text{years}}$$

where years is the number of years into the future.

(B) Revenue Estimates

A revenue estimate should be made for the range of high, low and expected patronage estimates. Passenger volumes, by category, can be multiplied bv the particular fare to be charged to yield estimated revenues for each category. It is often useful to reduce these estimates by ten percent to allow for revenue shrinkage and to keep the estimates on the conservative side.



(Source: ATA Transit Fact Book, Reference 11)

Annual Revenue Estimate:

o	Full-fare passenger X fare	______
o	Half-fare passenger X half fare	______
o	Special-fare passenger X special fare	______
	Total fares	______
o	Percent shrinkage	______
o	Net fare revenue	______
o	Advertising	______
o	Support from social service agencies	______
o	Other income	______
	Total revenue	______

3.2.11

When the revenue estimate has been assembled, mean revenue per passenger should be calculated by dividing the total revenue received by the number of passengers. Existing systems are collecting revenue per passenger in the following general range:

Service	Median	Range
General Market		
DAB	$0.29	$.21 to $.59
SRT	$0.45	$.37 to $.92
Target Market		
DAB	$0.37	$.08 to $2.10

If the estimated value falls toward an extreme of the range or outside the above guidelines, it would be wise to review both the fare structure and the method of calculating revenue.

At this point, a system is beginning to emerge from the myriad of design considerations. Before making facility and staffing decisions and finalizing the choice of an operator, it may be wise to review the system developed:

- Check it against needs and objectives.
- Review similar existing systems for comparison:
  - Are cost and revenue estimates realistic and within bounds?
  - Are supply and demand estimates within bounds?
- How do demand, supply, cost and revenue estimates compare with those estimated in the planning stage? If they are different, can you explain the difference?
- Check pitfalls to avoid. (See Section 3.3.)

3.3
Pitfalls

3.2.12 Select the Operator

(A) Coordination

Ideally, the operator selected should be familiar with the local community and have previous operating and managerial experience. Existing local transit and taxi operators should be involved in the planning and design of the system in an advisory capacity. In addition to the insights they can be expected to contribute, such a role will provide the local operators with insights into community objectives; direct contact with citizen groups, decisionmakers, and public agencies; and first-hand knowledge of the planning process.

Whether the operator is chosen from inside or outside the community, the operator's ideas should be included in design decisions.

(B) Evaluation

Distribute requests for bids to local operators and paratransit operating management firms. Include all passenger transit companies in or near the service area who have expressed an interest; otherwise, excluded operators may protest start of DRT service. Along with local needs, evaluate operator bids on these issues:

- Regulations and financial demands;
- Proposed costs;
- Familiarity with local physical, geographic, institutional, and social features;
- Community opinion;
- Access to additional equipment, personnel and financial resources;
- Availability for service;
- Contract flexibility and terms of termination; and
- Previous operating and managerial experience.

Existing experience has shown that the best operators may not necessarily be the best proposal writers. It is therefore suggested that community representatives meet with all potential operators to discuss and evaluate operational capabilities.

Any issues, problems or conflicts which arose during the design phase can also provide a focus for refining this list. For example, unfavorable community feelings toward particular operators or types of services may narrow the list of candidates.

The final decision will probably depend on the number and quality of providers with which a local public agency or transit operator may contract. In small cities, there may simply not be any providers, or only marginal providers not well respected by potential users. Canadian experience has shown that those operators ignored in the design process can often become the most vocal critics of the program. By enabling the operator to take part in the system's design, the transition from design to the actual operation of the service can be made much easier.

<u>(i) Access to Equipment/Availability</u>. Remember that the experience and availability of the selected operator will affect the relative speed of start-up. In general, if the operator has the necessary managerial expertise,

D 3.2.1
for a list of
potential operators

equipment, vehicles and personnel, and local subsidies are being used, a small-scale service may be implemented rather quickly. Otherwise, meeting federal funding requirements, ordering equipment and hiring and training a new DRT crew will considerably delay the start-up date.

(ii) Flexibility of Contract. Another determining factor is contract flexibility. Although DRT advocates do not like to admit it, a variety of factors can lead to a system's demise. If, for example, a service proves too costly, subsidies are not available, and fares cannot be raised to make up the deficit, the only alternative may be to terminate the service. Don't get caught in this situation with a contract that binds the community to several years of continuous operation. While no specific guidance is available, some contracts may be harder to terminate than others; this will obviously depend on the type of legal stipulations and work rules outlined in each contract. On the other hand, some communities may find it politically easier to terminate an outside contract than to be forced to fire public employees. Consider flexibility when deciding on who should provide the service, and again when drawing up the contract.

(iii) Managerial Considerations. Managerial experience is the most critical factor in reviewing candidates for operations. The importance of this function to the total service cannot be stressed enough. The general manager is responsible for creating the management information system, monitoring the daily operations (including staff decisions, equipment needs, budgeting and recordkeeping), and conducting service evaluations. The manager also oversees necessary service improvement plans and selected expansion or contraction of services. This director must therefore understand all of the system's functions, and be capable of assisting with any of the staff's responsibilities if and when necessary.

Management is responsible for generating a favorable public image. This means maintaining frequent contact with the sponsors, authorities, and advisory committees. Target market services will require additional contact with social service organizations and the riders. A manager's primary goal is to provide a service-oriented operation that is responsive to the needs of the public.

With these qualifications and the numerous responsibilities of the job, the general manager can easily be overextended in his personal work obligations. Typically, an overworked general manager jumps from one crisis to another, sometimes even substituting for an unavailable bus driver. The director must avoid monopolizing his time with tasks that can be accomplished more efficiently by other personnel. A good manager must therefore be able to allocate responsibilities to his supporting staff, allowing him to devote the necessary time to long-range obligations.

In small systems, the chief dispatcher often functions as the general manager of operations. In large systems, all dispatchers would be under a supervisor who would report to the general manager.

3.2.13 Design Facilities

The location and interior design of the control center, office, vehicle maintenance/storage facilities and transfer stations will depend upon the size and complexity of the system. In all cases, the type, function, and size of the equipment and the needs of personnel should be reflected in the design.

(A) Siting Suggestions

For maximum security and control, try to centralize all facilities. In many-to-one systems, locating the control center near the single destination can enable drivers to stop and pick up instructions and passenger lists, as well as permit customers to walk in for information or service. Where staff will share functions, proximate facilities will allow maximum efficiency in work schedules. If maintenance, storage, and/or fueling functions are to be contracted out to a local garage, try to minimize the distance between the control facility and the garage. Large systems, as in Rochester, New York, use satellite garages to provide space for vehicle parking, cleaning and minor maintenance. Using outlying facilities reduces the amount of unproductive driver time spent shuttling buses to the main garage, but also limit security and driver and mechanical supervision.

In Orange County, California, mobile maintenance vans travel to the vehicle for preventive maintenance. While this procedure is probably most applicable in mild-weather areas, it can reduce deadheading costs and the need for satellite facilities.

Radio reception may constrain the siting decision. Select potential antennae sites for clear reception.

(B) Facility Arrangements

It appears prudent to rent or lease existing facilities rather than invest in construction. This will allow ample time to precisely determine system needs and to assess whether the service will be successful or even survive.

Local government properties and facilities may be available for use. For maintenance purposes, consider municipal vehicle or local school district properties, especially in areas with declining school enrollment and therefore excess capacity. Investigate sharing space with similar community functions.

If existing facilities cannot be used, identify structures or space available for leasing. Make on-site inspection of offices and garages; anticipate at least minimum renovation work and expense. Contact reputable contractor for estimate based on interior design needs.

If no existing facilities or leasing arrangements are possible, consider constructing a new facility. Be prepared for possible delays; with time allowed for architectural and engineering design, UMTA grant approval, final design and actual construction, service implementation may be postponed up to one year and costs may balloon unnecessarily.

The system that starts small and anticipates growing as the demand for service increases should consider the expansion potential for its facilities. Capital investment in new facilities may eventually be required, and these expected costs should be identified. Cost estimates can be based on historical cost records or on bids from reputable contractors (Reference 4).

(C) Functional Design Considerations

(i) Control Center. Control center space must be designed and staffed to allow efficient communications and supervision among the telephone operators, schedulers, and dispatchers. If overdesigned and overstaffed, the system may fail due to inflated costs and, if it is understaffed, failure may result from poor or inadequate service.

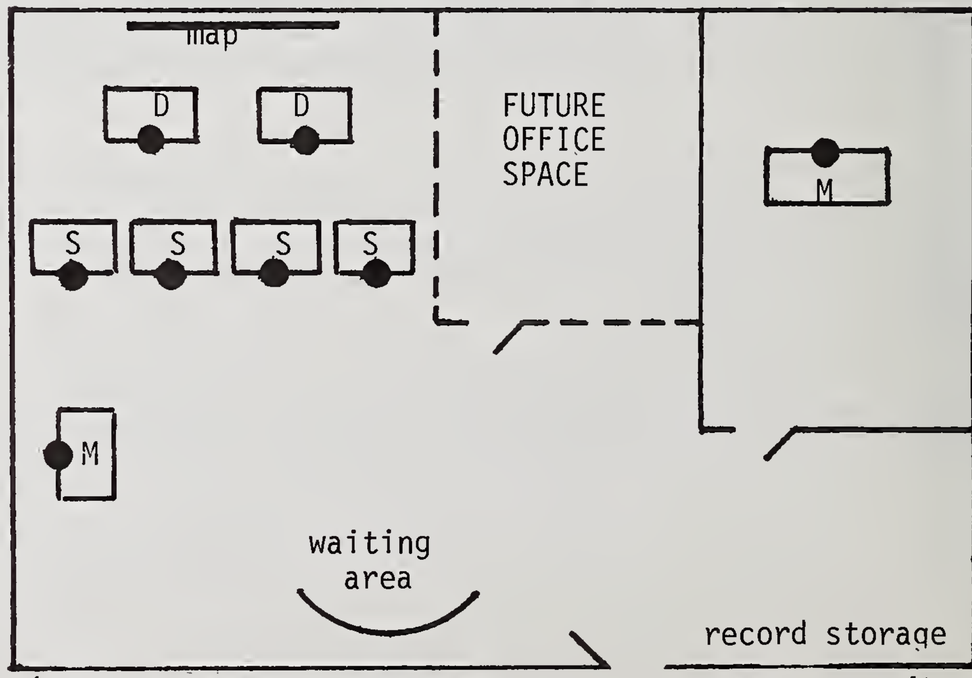
The control center layout should relate the field operations and the order taking, processing, and dispatching functions spatially. Arranging control room space to conform to the logical order of operation can help to cut down errors in handling requests. If the operating system is subdivided into several zones, the design of the control system might reflect the relationship between zonal boundaries.

Radio and telephone equipment placement must consider human needs for convenience and technical requirements for wiring. Estimate allowance of six to ten feet of extra cable on equipment to permit flexible arrangement. Position maps and visual displays to maximize their use. In Los Angeles' Watts control center, when trip tickets were not readily visible to the dispatchers, their use was discouraged and unsatisfactory passenger wait times resulted (Reference 75).

(ii) Office. Adhere to a simple office design based on the system's organizational structure. Position the manager's office centrally to make both clerical records and control center activities directly accessible for quick decisionmaking. Noise and confusion may necessitate separating office from control center functions.

CONTROL CENTER IN ROCHESTER, NEW YORK

SAMPLE CONTROL CENTER LAYOUT (Kansas City, MO)
(D = Dispatcher, S = Scheduler, M = Manager)



(Source: Adapted from KCMR DAR Study, Reference 31)

Administrative activities, staff selection, personnel training and other implementation activities will probably take place in the system office. Larger systems may therefore want to consider additional space for an adaptable conference/lecture/lunchroom. The costs of including some additional space for short-range expansion potential should also be considered.

To determine the size of facilities required, estimate the maximum number of personnel on duty and the spatial equipment requirements. Based on architectural rules of thumb, each staff member requires a minimum of 75 square feet to work efficiently. An additional 25 percent is generally added to account for washrooms, etc. (Reference 36). For a three-person control room, allow a minimum of 225 square feet, with an additional 56 feet for elbow room.

- o Review and identify structures suitable or adaptable for use
- o Prepare drawings of control center and support areas showing location of furniture, equipment, aids, etc.
- o Prepare cost estimates (see Design Section 3.2.11).
- o Coordinate construction efforts with other community agencies, such as the public works department.

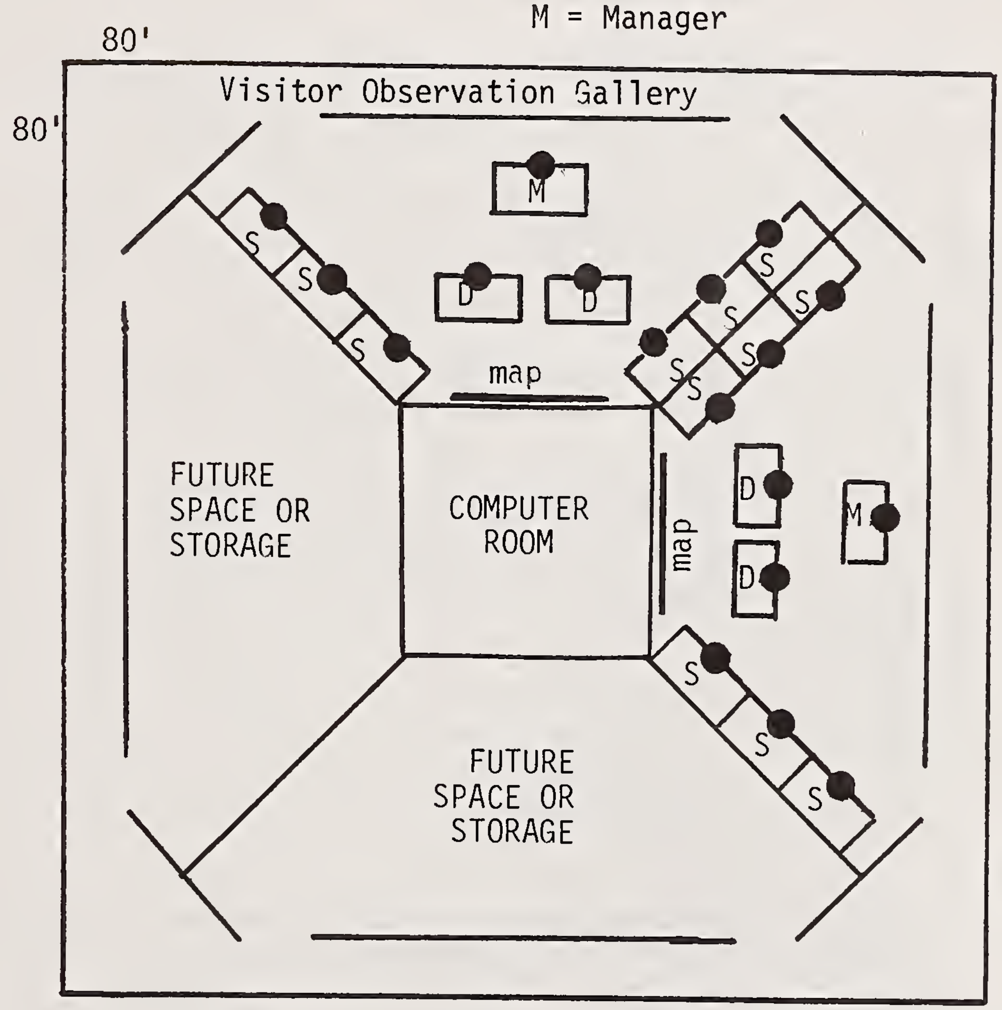
<u>(iii) Vehicle Maintenance, Servicing and Storage</u>. Vehicle facility design depends on service level anticipated, ranging from basic fueling and storage to a complete maintenance garage unit.

D 3.2.11 Cost Estimates

SAMPLE CONTROL CENTER LAYOUT

(Santa Clara County, California)

D = Dispatcher
S = Scheduler
M = Manager



(Source: Santa Clara System Design, Reference 48)

3.2.13

The facing checklist summarizes some of the options available in designing vehicle maintenance facilities. Approximately 2,000 square feet of space is required for each demand-responsive bus assigned to a general maintenance, servicing and storage facility.

(iv) Transfer Stations. Integrated services need facilities to accommodate passengers transferring between paratransit vehicles and other transportation modes. Earlier design work (Sections 3.2.4, 3.2.5 and 3.2.7) will have identified general areas for locating transfer stations and the expected design for each. Decisions made in selecting vehicles (Section 3.2.8) will provide information for station siting and space requirements.

Keep these suggestions in mind when planning the location and operation of transfer stations:

- Convenience, efficiency and safety can be enhanced with multiple-use stations. Regina, Canada is trying to coordinate its Telebus transfer points with community shopping and service facilities.
- Conflicts with automobile traffic can be minimized by posting no-parking signs.
- Minimize disruption of existing activities.
- Locate stations near the edge of a zone to avoid carrying passengers in the direction opposite from their destination.

No formal standards or guidelines exist for transfer facility design, even within conventional transit literature (Reference 33). Of course, transfer stations should

3.2.4 Tour Design
3.2.5 Detailed Demand Estimates
3.2.7 Fare Structure
3.2.8 Vehicle Selection

VEHICLE MAINTENANCE - SERVICE - STORAGE

OPTIONS:
- ☐ Main Garage
- ☐ Satellite Garage
- ☐ Mobile Repair Unit

Possible Functions

- ☐ Storage and Parking
- ☐ Fueling
- ☐ Washing
- ☐ Minor Maintenance, Repairs
- ☐ Major Overhauls

Additional Needs

Fencing

Lighting

provide protection from rain, snow, heat and wind, with room for standing and seated passengers. As much protection as possible from vandalism, assault or accidents should also be provided.

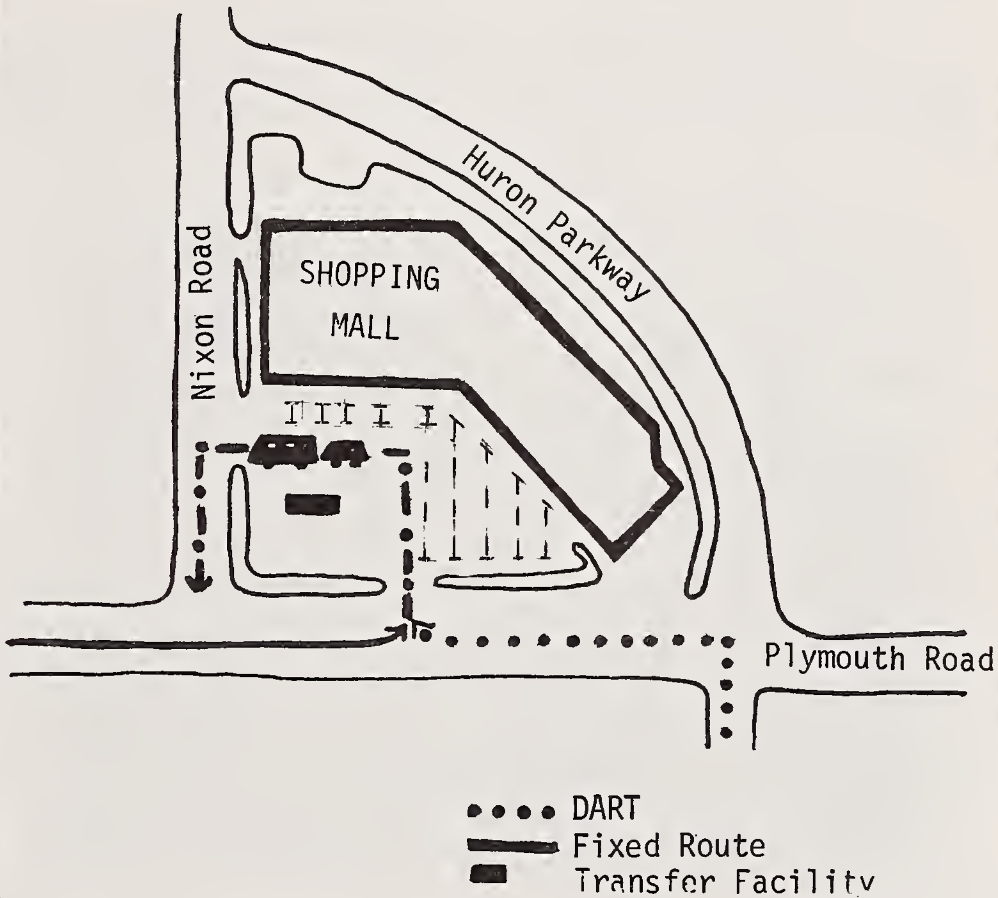
Include lights if service is offered after dark; lighted stations enhance safety for drivers and passengers, and enable travelers to identify oncoming transit vehicles.

Maps, route schedules, and a telephone (regular or direct dial to control center) can be mounted on the walls, and the station should be cleaned and user information restocked as needed.

Additional special design requirements for target market groups are included in Section 4.2.8 (System Characteristics).

The final design for each transfer station should identify its exact location and incorporate all desirable features.

SAMPLE TRANSFER FACILITY



Passengers riding the Ann Arbor paratransit system can transfer to a fixed-route bus at Plymouth Mall, where a shelter is provided with benches, bike rack and free Dial-a-Ride telephone. Transfer station is located in an accessible, but relatively traffic-free corner of the mall parking lot.

(Source: Ann Arbor, Reference 66)

4.2.8
Target Market
Equipment

3.2.14 Develop Marketing and Public Relations Program

(A) Objectives

An effective marketing program is more than advertising and public relations. The six objectives listed below suggest the scope and intent of a marketing program:

- o Reflect an understanding of consumer needs;
- o Create a receptive community environment;
- o Build patronage;
- o Build confidence in the system;
- o Communicate clearly how to use the system; and
- o Convey an understanding of the transportation options available, where more than one type of service is offered.

The facing exhibit suggests marketing tasks to be undertaken in meeting these objectives, and outlines an ongoing program through several stages of system development. The first task, to assess the marketing implications of system plans, is a reminder that marketing personnel should be kept well informed of planning and design developments.

(B) Guidelines

<u>(i) Determine data requirements for market analysis.</u> To assess the market for the proposed system, information is needed on:

- o Community objectives;
- o Transit needs;

MARKETING TASKS

	System Stage	Guidelines Section
• Assess marketing implications of system plans	Planning, Design	3.2.14
• Determine data requirements for marketing analysis	Design	3.2.14
• Develop a marketing plan	Design	3.2.14
• Develop a budget	Design	3.2.14
• Develop schedule of events	Implementation	4.2.6
• Develop & distribute marketing & user information	Implementation	4.2.6
• Arrange community presentations & media coverage	Implementation	4.2.6
• Monitor system progress - Announce any changes or good news - Prepare any special promotions - Carry out schedule of events or modifications	Operation	---
• Monitor effects of marketing efforts - Survey if necessary	Operation	---

(Source: SYSTAN)

- Travel patterns; and
- Travel preferences.

Much of this information will have been developed during the planning stage from local data sources, and refined during the design stage. This material should be reviewed by marketing personnel to determine whether it adequately describes the marketplace to be served. If not, additional information may need to be collected or surveys taken (see Section 3.2.2 for survey guidance).

With a few exceptions, extensive survey work and data collection have not been a part of the market analysis undertaken by existing systems. Many operators stated that they simply looked at other operating systems for guidance.

Once the system has started, data on ridership characteristics and system operations are available from different sources (dispatch logs, fare information, etc.). On-board and telephone surveys have been used in existing systems to gather information on changes that might be needed, community attitudes, system riders and rider usage.

<u>(ii) Develop a marketing plan</u>. Existing systems have generally started marketing efforts with an awareness that the impressions generated in the early stage are important in creating valuable word-of-mouth advertising. When the system is fully in operation, the marketing program can be expanded if necessary.

To develop a plan, various tools are at hand to create a positive image of the system:

D 3.2.2
Advance Surveys

PERT Dial-A-Bus Vehicle, Rochester, New York

- The vehicle: A flexibly-routed vehicle is highly visible as it circulates throughout a community. Aided by an attractive logo and/or color scheme, the vehicle itself becomes a mobile advertisement. In Grand Rapids, Michigan, one quarter of the riders learned of the services by seeing the buses on the streets.

- The vehicle drivers: These traveling salesmen of the system are an important point of contact with the riding public, and drivers' knowledge and attitudes about the system are factors in its successful operation.

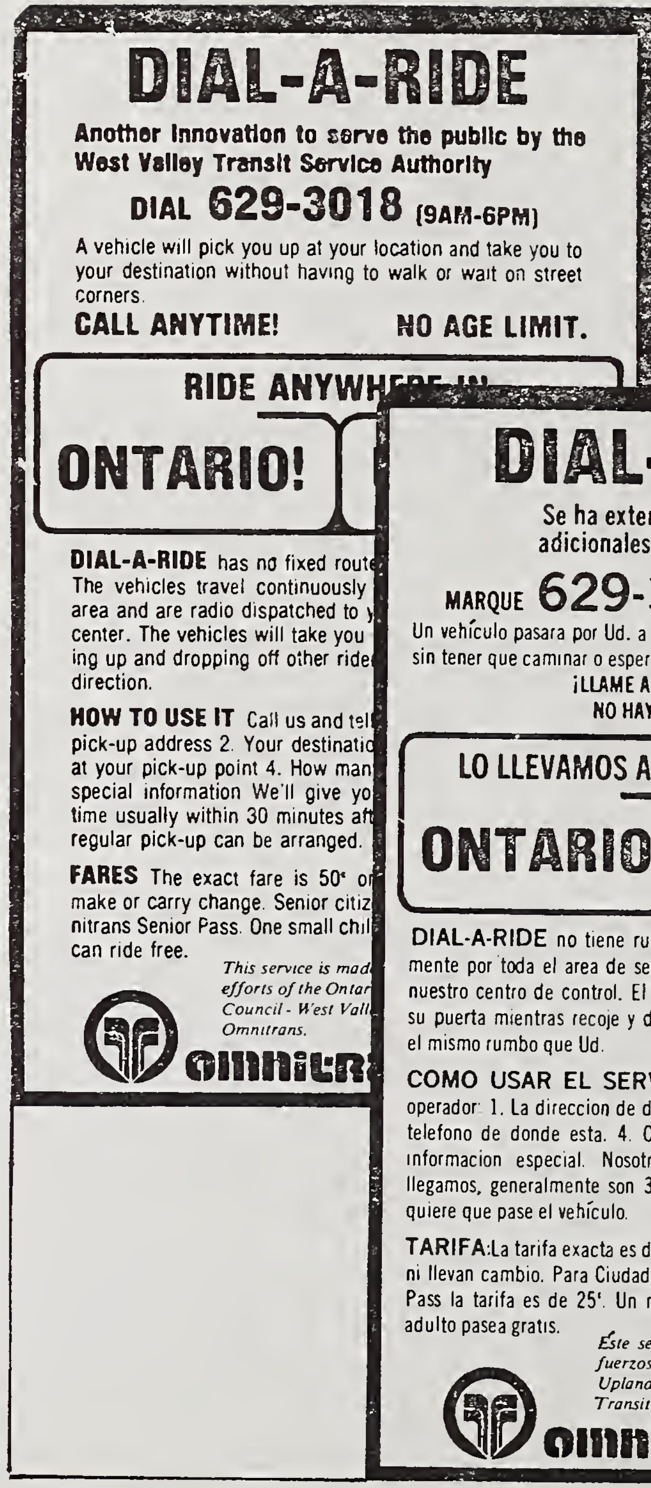
- Informational brochures. These should clearly describe how the system operates and how to use it.

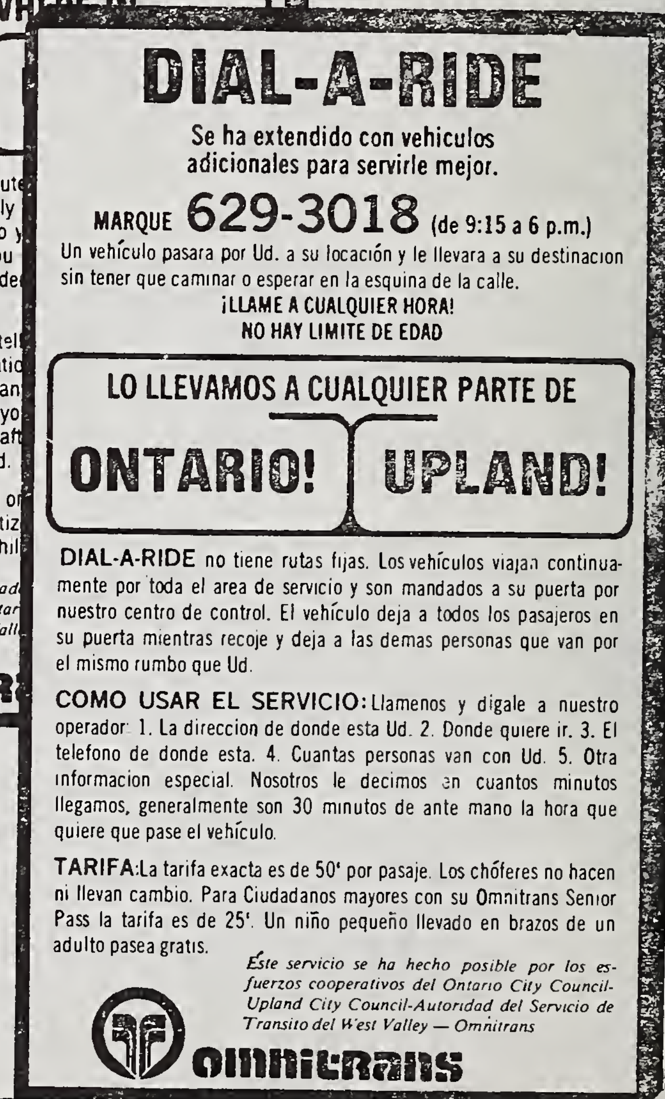
- Media coverage: Use of the media includes placement of ads, reports by local news staff, press conferences, etc. Good relations with the press need to be maintained.

- Personal contact with the community: Community backing is vital to the continued health of the system. Personal contact with community groups is an important link for generating support and understanding of the system and community goals. To initiate community support in Fairfield, California, a local group sponsored a contest to name the system

- The telephone: The public's first contact with the system is generally the unseen person answering the telephone. Public relations can be improved by training the telephone staff to impart information courteously and clearly.

If people in the service area speak English as a second language, consider printing brochures in Spanish, Chinese, etc.





It is generally advisable to establish two numbers: one for information and one for service requests. The large Santa Clara County system started with only one number and was overwhelmed with calls.

- Service promotions: These are typically special events such as opening day ceremonies, reduced- or free-fare days, direct mailings of tickets to households, etc. Evaluation of reduced-fare promotions in Greece, New York found them to be useful. Direct mailings are considered to be most effective and used most often. They are a mechanism for reaching the households in a service area more directly than through local newspaper ads. In Regina, Saskatchewan and Westport, Connecticut, telephone stickers with the system number were mailed to homes. Other cities have had system information mailed with the city water bills.

- A complaint and information file: Maintenance of this type of file gives an early warning of the public's problems with the system.

A basic marketing strategy suggested by the State of Michigan (Reference 50) includes:

- Continuous visibility provided by the buses.

- Use of the fact that service initiation, modification, expansion or progress is genuine news in any community, deserving and likely to get extensive print and broadcast news coverage.

- Simple, readily available information on how to use the service--placed so that potential users have it when they are making travel decisions, if at all possible.

- An organized program of information availability via telephone, with follow-up.

- Maximum use of word-of-mouth information, by initiating direct presentations to identifiable groups and encouraging people to talk to others they know. Leave them with brief printed material to spread around.

- Selective use of pricing and "specials" if necessary.

- Above all, continuous attention to the quality of service. If riders' experiences with the system are positive, they will spread the word.

- If, after some period of operation, the system is underutilized, then a campaign to increase public awareness may be in order.

Samples of marketing and customer information materials are included in SCRAPS Section 4.2.

4.2
Sample Marketing
Materials

(iii) Develop a Budget. Marketing budgets for existing systems have varied from a few hundred dollars to several thousand dollars. Two kinds of budget costs exist: start-up costs and continuing marketing expenditures. Some systems have started purposely with a minimum amount of advertising while the new system worked into a smooth operation. Other operators, anticipating a passenger demand that might exceed their system's capacity, also began with a minimum of advertising.

Costs which are often not reflected in budgets, but are time-consuming tasks, include staff time spent in public relations training for new system operation; volunteer and staff labor often used to distribute information or give presentations to local groups; and staff work to develop a marketing plan.

Sample marketing budgets for systems operating in communities ranging from 16,000 to 90,000 people are presented in the facing exhibit. A breakdown of how many marketing dollars have been spent may be found in SCRAPS Section 4.5 , along with a complete marketing proposal for Fairfield, California. (4.1).

SAMPLE MARKETING BUDGETS

		First Year	
Location	Population Served	Operating Cost	Marketing
Ann Arbor, Michigan Pilot Program	16,000	$ 35,000	$ 3,151
Michigan DART Program	20-30,000 (typical)	96,000	2,000 start-up funds 200 per month, ongoing
Westport, Conn. (Demo)	30,000	466,071	18,000 (contract to private firm)
Fairfield, California	40,000	162,000	1,400 start-up funds 500 per month, on-going
El Cajon, California (shared-ride taxi)	60,500	120,000	5,000 city funds
Regina, Saskatchewan (feeder to fixed-route system)	63,000	218,500	3,500 all advertising and opening day ceremonies *
Greece, New York (Pre-Demo) (Demo)	69,000	304,000	28,000 start-up funds 1,167 per month, ongoing 4,240 per month, ongoing
Syracuse, New York (Oemo)	90,000	208,000	4,643

*The system introduction in late 1971 received local and national exposure, so additional advertising was unnecessary.

(Source: SYSTAN)

4.5 Marketing Budgets

4.1 Marketing Plan

3.2.15 Develop Staffing and Training Plan

The success and efficiency of this labor-intensive service depends greatly on individual personnel capabilities and the arrangements under which labor is employed. The majority of successful small DRT operations have instituted flexible, shared staffing arrangements that embody a spirit of teamwork.

(A) Union Labor Constraints

Review information compiled during the planning and design phases, paying particular attention to Section 2.2.4(B) and the local labor situation, noting any union contracts, rules, and established wage rates.

Generally, when the staff is unionized, opportunities to employ part-time workers will be limited, wage rates will be higher and work scheduling less flexible. Initially the need to adhere to specified union work rules will constrain staff selection and driver assignments.

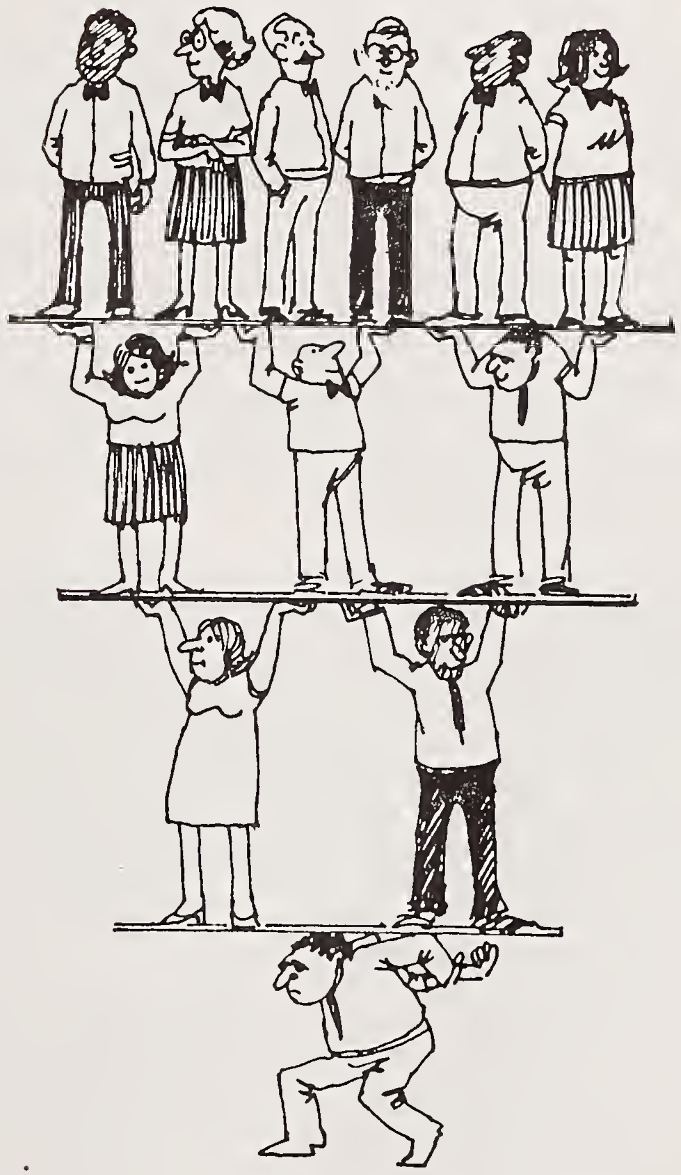
Communities with locally-controlled unions or a compatible relationship between labor and management appear to have greater flexibility and to operate more cost-effectively than the larger, more formally organized cities.

(B) General Guidance

Staff needs depend on the operational requirements for administration, driving, maintenance, scheduling, dispatching and communication. The previous estimates of personnel, daily and peak-hour ridership, fleet size, equipment and

P 2.2.4(B) Labor

PARATRANSIT PERSONNEL PYRAMID



(Source: USDA, Reference 261)

cost can be used as a guide in estimating the types of job classifications and the size of the initial staff.

The personnel requirements of existing systems may be gleaned from the system summary sheets in the Appendix; however, staffing requirements will vary according to individual constraints, personnel capabilities, methods of operation and management style.

Additional personnel needs will emerge with operating experience. Rochester, N. Y. revised their management structure toward the end of the first year of operation, allowing the manager to deal with unexpected problems in the field, freeing the manager's assistant for in-house administrative tasks, and moving the senior dispatcher on to head the control center.

(C) Size of System

In general, the larger the system, the greater the number of personnel required. Larger operations are more likely to automate functions, thus eliminating some control center jobs. Examination of existing systems suggests that 10 to 20 vehicles, depending on individual service characteristics offered, can be handled manually; employing more than 20 vehicles will probably require computer capabilities. If automation is required, additional technical staffing support during implementation should be provided. See SCRAPS - for computerized system details.

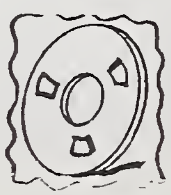
In small systems, a dispatcher will be able to handle all the controller functions, with some assistance in peak periods, whereas larger systems will require several dispatchers plus telephone operators and support staff. Operations supervisors, typical

DISTRIBUTION OF LABOR COST COMPONENT OF OPERATING COST FOR 28 DRT SYSTEMS

LABOR COSTS AS % OF OPERATING COSTS	% OF SYSTEMS	NO. OF SYSTEMS
40 - 50	11%	3
51 - 60	29	8
61 - 70	32	9
71 - 80	21	6
Over 81%	7	2
TOTAL:	100%	28

(Source: SYSTAN)

Go to A-4 Employees in System Summary Sheets



2.0 Use of Computers

of larger systems with 10 or more vehicles, can be hired initially, or selected by promoting an outstanding dispatcher, as the system expands. In smaller cities, staff sharing arrangements may be made with other utilities or civic agencies.

Paratransit services that are extensions of existing local public agencies or transportation companies should be able to draw on the staff and services already available. In Ann Arbor, Michigan, drivers and dispatchers were drawn from the regular pool of Transportation Authority drivers on a bid basis. Extra drivers were hired and trained for both fixed and flexible route service and were expected to substitute freely.

U — Some drivers with considerable seniority in fixed route service may not be able to handle the different requirements of DAB service.

(D) Personnel Considerations

Identify the "core" designers to be brought into the implementation and operation phases. If work rules permit, hire personnel on a part-time or split-shift basis.

(i) Part-time. Experience shows that employees hired part-time:

- tend to be more productive because they are less prone to exhaustion from long hours, an important consideration for drivers and dispatchers who are expected to maintain a pleasant public relations attitude.
- provide fairly inexpensive manpower, available in most communities ($3 to $4 per hour in 1975).
- require fewer fringe benefits, such as paid lunch hours and insurance coverage.
- simplify the extra board function, as they can work full-time when the demand warrants.
- result in larger pool of trained drivers and dispatchers, available to cover absences, emergencies, or peripheral activities, such as training new hires, conducting surveys and data collection, or assisting in marketing effort.
- have traditionally been used throughout the taxi industry to supplement full-time drivers.
- can be housewives, students, retired citizens.
- may result in higher employee turnover rates.

(Reference 43)

(ii) Staff Sharing. Ideally, individual employees should be qualified for more than one position to retain the greatest amount of flexibility and provide maximum work schedule coverage. Combination positions tried elsewhere include: driver/controller, operations supervisor/dispatcher, secretary/telephone operator, scheduler/dispatcher, and even project director/dispatcher. Shared personnel arrangements can prevent service from being disrupted due to driver illness, dispatcher's tardiness, other staff's absence, turnover, or changes in assignments.

However, high rates of absenteeism and turnover as experienced in Los Angeles' Watts service placed heavy burdens on the remaining call takers, dispatchers, drivers, and management.

Drivers cannot be expected to function as dispatchers as well as vehicle operators, nor can dispatchers engage in additional administrative activities instead of scheduling and routing vehicles.

Although flexible arrangements are advised, mismatching staff resources will adversely affect employee attitudes and job performance, inevitably degrading the level of service and the system's public image.

Wage differentials may also foster individual job preferences. Most non-unionized demand responsive operations offer small wage differentials in favor of dispatchers (approximately 25¢/hour higher than drivers), justifiable on the basis of the greater job responsibility (Reference 43). In such cases, multi-function staffing pay-scales may become complicated. In these situations try assigning specific daily job responsibilities with mutual assignments to cover emergencies. Try to anticipate personnel changes and remain flexible to handle unplanned shortages.

(E) Employee Estimates

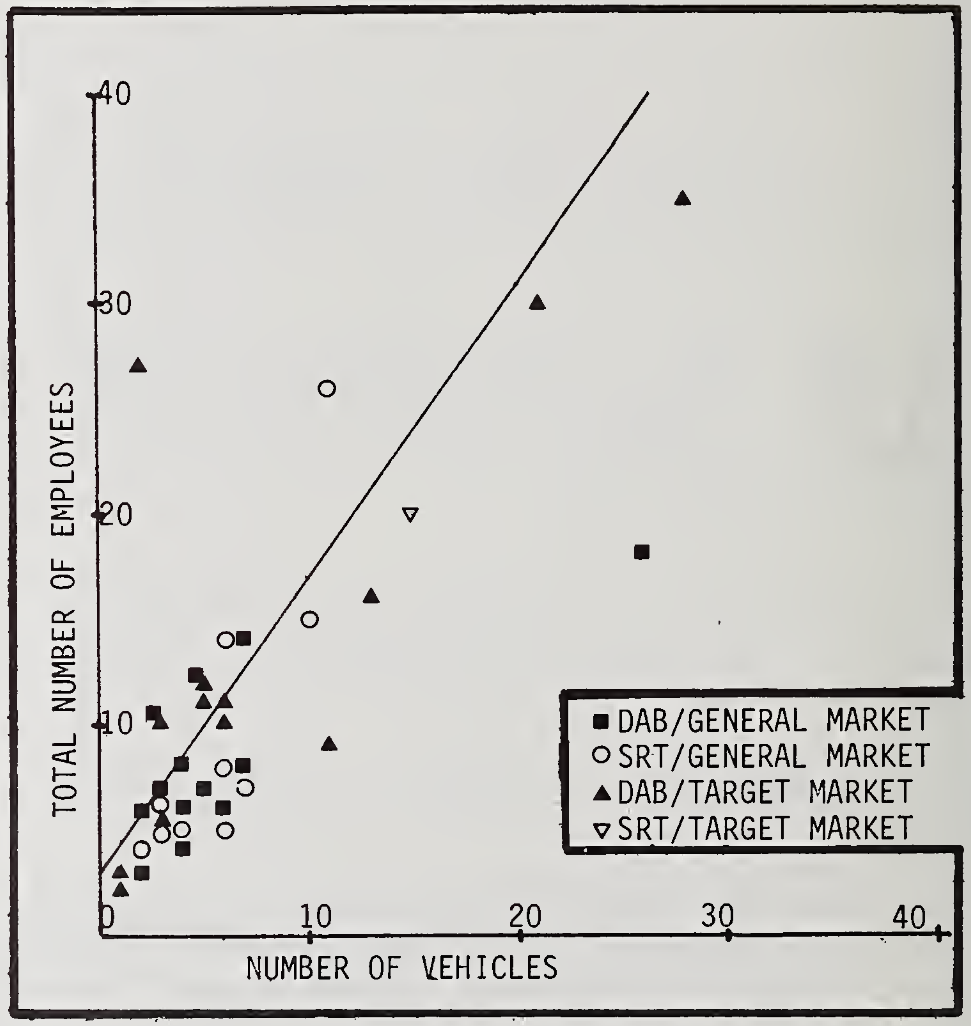
Statistical analysis of staffing needs show a high positive correlation between total number of employees and fleet size. The 24 general market DAB systems surveyed suggest:

Total employees = 1.4X (fleet size) + 2.9

Thus, for a five vehicle system, approximately ten employees would be needed (1.4(5) + 2.9 = 9.9)

<u>(i) Drivers.</u> The largest staff need will be drivers. A sufficient number of drivers to cover each peak period

EMPLOYEE ESTIMATES



(Source: SYSTAN)

vehicle in the fleet, plus extra drivers to compensate for illnesses, vacations and turnovers should be hired. Estimate one full-time and one part-time driver for each peak hour vehicle in use to cover 12 hours of service per day, including weekend service (Reference 187). Extending or contracting the number of hours of service alters this estimate accordingly:

For 8 hours of service:

Number of Drivers = 1 x (Number of peak hour vehicles)

For 16 hours of service:

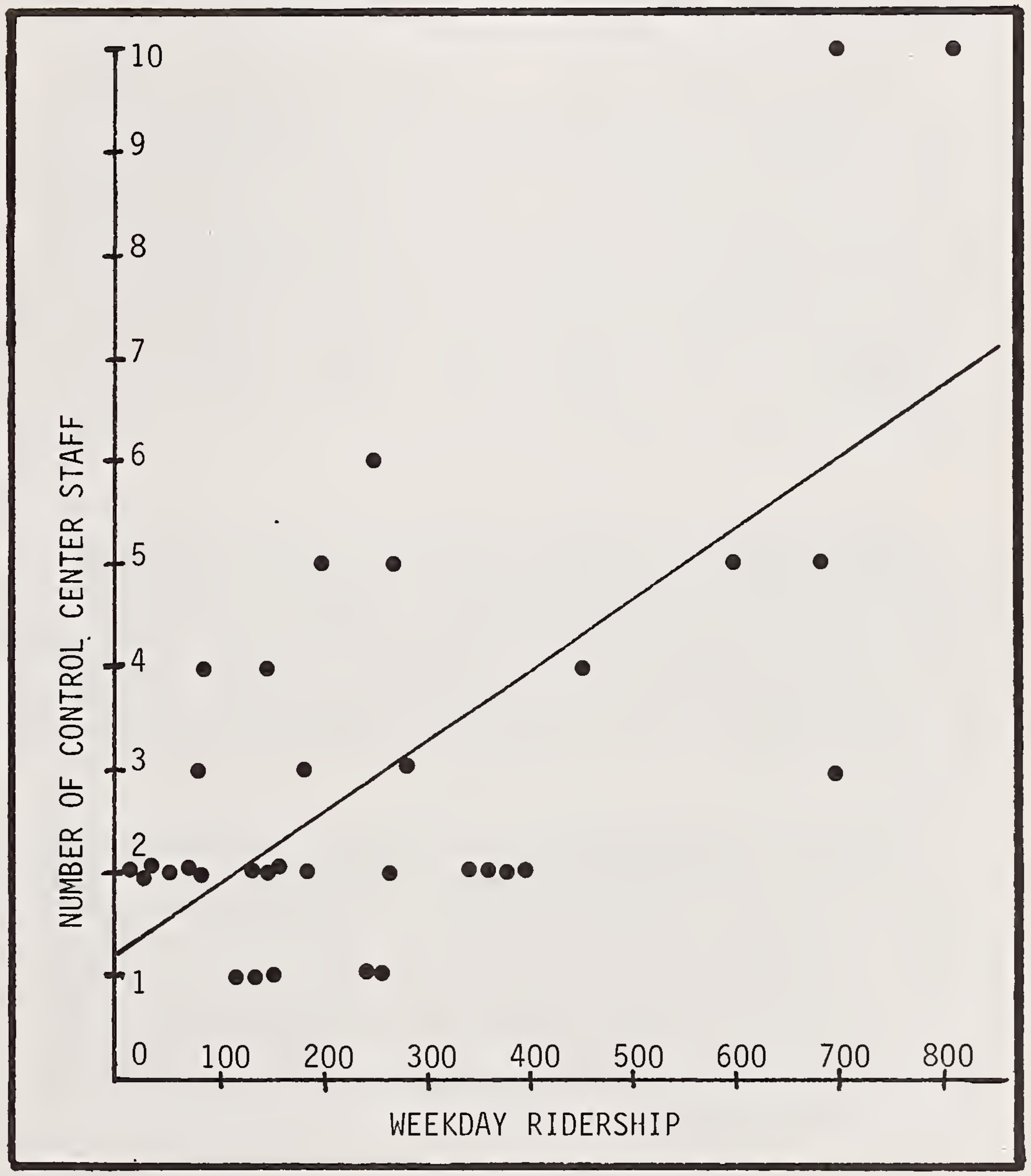
Number of Drivers = 1.7 x (Number of peak hour vehicles)

(Reference 36)

These guidelines assume non-unionized operation, as work rules may mandate the number of drivers on duty during any period.

(ii) Control Center. Staffing needs can be estimated by peak-hour demand levels. Existing systems show the number of calls one telephone operator can handle ranging from 30-120 calls per hour. These estimates will be high for services just starting up. Make conservative estimates for the initial period of service when staff is inexperienced and the demand for information will be high. Initially estimate one telephone operator for each peak period of 60 calls, based on a 12-hour day. It is a good idea to provide special information operators during start-up and the first few weeks of operation. As the control center staff gains operating experience, productivity levels

CONTROL CENTER STAFF ESTIMATES



(Source: SYSTAN)

will increase, permitting minor expansion and/or additional demands to be adequately served with the existing staff.

Staffing levels will also depend on whether telephone operator and dispatcher duties are shared, as well as the type of equipment and access mode used. Experience shows schedulers and dispatchers handling a range of 75-200 demands, varying according to division of personnel duties, and operating characteristics. The greater demand estimates reflect zonal configurations, whereas the lower range reflects the more labor-intensive many-to-many demand-responsive services.

(iii) Support Staff. The estimates are not well documented. While all systems need a general manager, generally assistant managers and/or operations supervisors as well as secretarial and administrative personnel are necessary only if daily ridership is greater than 500 passengers/day, service is provided for 16 or more hours/day and/or 10 or more vehicles are in service. (Reference 43)

Current experience does not allow maintenance staffing needs to be precisely defined, primarily due to the widely varying mechanical demands of different vehicle models. However, approximately 2-4 maintenance staffers appear adequate for a 15-bus operation, with one supervisor coordinating and diagnosing major problems; one to two mechanics to cover all hours of vehicle operations, and one cleaner/checker/janitor/mechanic's helper for miscellaneous tasks.

3.2.1
Selection of Technical Support

(F) Job Descriptions

The following job categories represent for the most part a list of functions rather than a series of separate positions. In most systems, the functions will be accomplished by a small group of individuals and the precise nature of any position will be shaped by the mix of individuals who first perform the tasks.

- Driver
- Control Center
  - Telephone operator
  - Scheduler
  - Dispatcher
- Support Staff
  - Bookkeeper/Clerk
  - Marketing
  - Maintenance

(G) Training Plan

Although the manager will be continually monitoring personnel operations to ensure the quality, safety, courtesy, and efficiency of the service, an initial staff training program is essential. Paratransit provides a more personalized service than conventional fixed route transit, and the close, continual interaction of employees with the public influences the ultimate success or failure of the system.

A decision on whether to perform the training program in-house or to contract out for such services, reviewed in Section 3.2.1, should now be finalized. It has been noted that social service agencies and taxi operaors, especially in non-urbanized areas, may not provide adequate training programs. If your community has any special requirements or needs, these should be outlined and explained to the selected training instructors. For example, Santa Clara County, CA. included rudimentary Spanish lessons in their training program because of the large number of Spanish speaking residents.

(i) Training Policy. In-house personnel should be identified and assigned responsibility for the program's development. The manager and selected training instructors should outline a basic training policy to guide the planning and implementation of the program. Suggestions for training:

-System functions should be explained in a logical sequence (i.e. request, scheduling, and then dispatching service).

-Subjects should always be introduced with supporting documentation. Identify potential training equipment, aids (See Section 4.2.3) and auxiliary instructors, such as firemen, police or community leaders for safety, dispatching, or first-aid lectures.

-Take into consideration that age differentials and learning capabilities will vary greatly; attention spans will be short.

-Provide practice sessions and actual on-the-job experience.

If system is automated:

-Present the computers as useful tools, not as objects to blame for error.

-Drivers as well as control center staff should know the how and why of computer operation.

Adequate preparation by the trainer is crucial. Construct plenty of training tools in advance of the program to avoid the problem of "running out" of material.

(ii) Time Schedule. Experience has shown that approximately two to four weeks should be set aside for staff training purposes. This time should be divided into classroom lecture and discussion periods, followed by dry-runs or simulations of actual operations. Additional time should be set aside to develop and refine the employee training schedule and program just prior to getting underway.

In Columbus, Ohio, insufficient time was allotted for training simulations prior to service, but because initial demand was low, it was possible to run simulated practices during the first few weeks of operation. Their consulting agency acted as a trouble-shooter to oversee these operations and assisted in identifying and averting potential pitfalls.

In addition to pre-operation instruction, the plan should include some provisions for on-the-job training for staff hired after the start of service.

I 4.2.3
Obtain
Equipment

3.2.16 Prepare Implementation Budget

At this point, an implementation budget can be put together along with a cost estimate for operations. While such estimates are meant to be custom-fitted to each community, information in each case should include:

- Estimated costs for the first year of operation for the level of service proposed,
- Details of funding for the system,
- The proposed fare structure, and
- Estimated revenue.

If a management firm is to operate the system, the contract cost and work tasks should be itemized and added to the list; the contract used in Orange County, California is shown in SCRAPS Section 6.4 and can serve as a sample.

If a contract is to be signed with a bus operator or shared-ride taxi firm, the details of payment--including any incentive arrangements and estimated cost of operation--should be worked out. (See Section 3.2.1 for sample types of taxi contracts.)

The following pages illustrate budget items that include most items reported by demand-responsive transportation operators. The major cost divisions are capital, implementation, and operating costs. (Demonstration projects will require an additional set of estimates.) Implementation costs are sometimes capitalized, since they are non-recurring.

Budget costs are generally based on the detailed cost estimate (see Section 3.2.11) and updated with the latest design changes. It is appropriate to update equipment and service bids if requirements have changed or more than six months have elapsed since estimates were last made.

Operating costs need to be reviewed on a continuing basis. Estimates should be reviewed regularly during implementation and as the operator gains experience (Reference 41).

In developing a budget, note those cost-free items, such as volunteer services or donated equipment, and estimate fair market dollar value for each one. An accurate portrayal of real system costs, by including these items in total costs, will help in estimating and controlling future project budgeting and accounting procedures.

In integrated fixed-route and demand-responsive operations, care should be taken to separate or apportion those costs which are shared between operators, such as a control center staff, etc.; otherwise, the demand-responsive portion of real costs will not be known.

3.2.1(D) Taxi Contracts
3.2.11 Detailed Cost Estimates

6.4 Sample Management Firm Contract

BUDGET ITEMS

Capital Budget

Vehicles
- Type A
- Type B
- Handicapped Equipment

Fare Collection Equipment

Communications Equipment

Maintenance Equipment

Shelters

Facilities
- Maintenance
- Office/dispatch

Miscellaneous

Implementation Budget

Personnel
- Administrative
- Staff
- Drivers
- Planners
- Engineering

Training
- Materials
- Facilities

Marketing

Contractor Support
- Planning
- Advertising
- Architect
- Engineer

Miscellaneous

Operating Budget

Personnel
- Drivers
- Dispatchers
- Maintenance
- Administrative

Vehicles
- Fuel
- Cleaning
- Service

Maintenance
- Vehicle
- Communication
- Other

Fare Collection

Insurance

Marketing

Administration

Depreciation
- Vehicles
- Equipment
- Facilities
- Shelters

Contract Services

3.2.17 Present System Design

The system concept to be presented to decision-makers and the rest of the community at the close of the design process is far more detailed than the concept produced by the planning process. Since that presentation, the system may have changed a lot or a little, depending upon community reaction, cost assessments, etc.

Since the addition of this system will affect the whole community and may represent a substantial financial commitment, information about the proposed system should be widely circulated. Making presentations to explain the new service in several different locations within a community is highly recommended. These presentations have secondary effects of increasing awareness,and encouraging ridership, for the system.

In Ann Arbor, Michigan, the transit authority proposed an expanded system for both neighborhood service and feeder service to the fixed-route bus system, as a follow-up to a pilot project from 1971 to 1972. The system plans were described"in sufficient detail so a realistic budget could be developed" for the city council and the citizens of Ann Arbor and covered the following information:

- Background;
- Pilot program findings;
- Proposed citywide plan including comparison to existing systems;
- Alternatives considered;
- Benefits;
- How system works;
- Ridership estimates;
- Geographic coverage;
- Vehicles, equipment, and support facilities;
- Financial analysis, including yearly operating costs, funding, fares, and revenues; and
- System implementation.

This proposal was prepared in support of a tax increase for transportation purposes to be voted on by the citizens of Ann Arbor. It was approved by the voters.

SAMPLE DESIGN PRESENTATION

Presentation Materials

Area: The Heights, California
Service Area Size: 6 sq. miles
Population: 26,000
Population/sq. mile: 4,300

Service objective: transit service for general public, but primarily for elderly and handicapped

Service area: entire city

How many will ride? 320 passengers/weekday
range: 250 to 400 passengers/weekday

Basis/Back-Up Materials

	Reference Section:
	P
. Identification of transit needs of city's elderly & handicapped with their assistance from meetings held during design development	2.2.1 2.2.2
. Assessment of existing service	2.2.3
	D
. Assessment of potential sites	3.2.3
. Talks with advisory & community groups	
. Worked through demand-estimating techniques	3.2.5
. Looked at other systems	A-4
. Identified additional potential patronage in unincorporated area northwest of city boundaries	3.2.3

Presentation Materials

Funding sources:

Transportation Development Act (SB325)

- Available for capital and operating funds
- Application required, due by April 1 for FY funding
- Requirements/Limitations: coordination with existing transit system (countywide fixed-route bus)

Hours of operation:

Mon.- Fri.: 7 a.m. to 7 p.m.
Saturday : 10 a.m. to 4 p.m.

Fares: many-to-few	50¢	
many-to-many	75¢	regular
	25¢	elderly & handicapped
transfers	10¢	

Operator: City operation

- Recommend reassigning a member of Public Works Dept. with transit experience to be Manager of operation
- Integration of facilities, equipment, control center possible
- No major purchases necessary other than vehicles

Basis/Back-Up Materials

	Reference Section:
. Preliminary discussion with regional authority that approves application & channels funding	
. Transfer points: 4 - 2nd and San Antonio - So. Pacific Railroad Station - 8th and Oak - Intercity bus stop	
. Looked at other systems	A-4
. Higher fare to constrain demand; easier to lower fare later	3.2.7
. Took bids from taxi companies	3.2.1
. Management firm estimate	3.2.12
. Assessed city staff	
. Checked facilities	3.2.13
. Equipment needs	3.2.9/10

Presentation Materials

Proposed service option: dial-a-bus

Proposed system name: The Heights Hopper

- many-to-few : peak, off-peak hours
- many-to-many: shuttle for shoppers 10 a.m. to 3 p.m.

Where does the money come from?

Fares: $10,000
State: $280,000 Source: SB 325
City: $ 5,000 Source: Revenue Sharing

Where does the money go?

Capital costs: $132,000

Operating costs: $163,000/year
$ 2.00/passenger (estimated)

Basis/Back-Up Materials

	Reference Section:
. Reconsideration of subsidized taxi service option as requested after planning stage	3.2.1
. Loop configuration for downtown circulation during off-peak hours	3.2.4
. Operating and capital cost estimates	3.2.11 3.2.16
. Revenue estimates	
. Looked at other systems - cost/passenger trip - revenue/passenger trip - cost/vehicle hour	A-4
	3.1

Presentation Materials

Other operational considerations:

- Labor: drivers
- Marketing: city staff
- Ordinances: no changes necessary
- Licenses, permits: application to FCC necessary for radio channel unless possible to share one with fire department

  lead time: 4 months if new channel
- Insurance: vehicles will be covered under city policy

Precedents: comparable system operations exist in areas of similar size, population and density

Basis/Back-Up Materials

	Reference Section:
. Talks with local union indicate no problems; discussion of work rules is continuing	3.2.14
. Talk with insurance company representative handling city insurance	
. Systems # 4, 29, 42, 47, 68, 74	A-4

DECISION POINT

Approval is needed at this point to proceed to implementation, the "get ready" stage before operations begin. If approval is given, funding applications will be submitted and major commitments will then be made to obtain vehicles and equipment, train staff, and set up operating procedures.

3.3 Design Pitfalls

This section summarizes the major pitfalls to be avoided in designing paratransit systems, as assembled from the literature and reported by operators of current and defunct systems.

- Poor Ridership Projections
- Vehicle Variety
- Failure to Update Demand Estimates
- Underestimation of Telephone Service Times
- Splitting Staff Duties Unwisely
- Area/Fleet Mismatch
- Rider/Vehicle Mismatch
- Inadequate Information Materials
- Pinpoint Arrival Prediction
- Poor Control Room Design

POOR RIDERSHIP PROJECTIONS

Overly-optimistic projections of demand can lead to high deficits, while overly-pessimistic projections can lead to under-design and the early swamping of the system. Typically, uncritical acceptance of survey responses regarding promised rides will lead to overly-optimistic projections of ridership.

VEHICLE VARIETY

Too much variety in the vehicle fleet can lead to maintenance nightmares.

FAILURE TO UPDATE DEMAND ESTIMATES

Any changes in fares or operating policies made by decisionmakers or designers should be reflected in subsequent demand estimates. In Santa Clara County, the political decision to offer a flat 25¢ fare instead of the 50¢ fare used in projecting demand originally was never reflected in the demand estimates. This oversight contributed to the mismatch of supply and demand, which swamped the system in its infancy.

UNDERESTIMATION OF TELEPHONE SERVICE TIME

Another problem in Santa Clara County stemmed from unrealistic early estimates of the time required to handle telephone requests for service. The time was grossly underestimated, with the result that far fewer telephone lines and operators were initially available than were needed. Established systems report call-handling times ranging from 40 seconds to three minutes, but the processing of telephone requests can be expected to take longer during the crucial early weeks of service.

SPLITTING STAFF DUTIES UNWISELY

Although staff flexibility is desirable, dispatchers cannot be expected to function as administrators while taking calls and routing vehicles, nor can drivers act as dispatchers while behind the wheel.

AREA/FLEET MISMATCH

Attempts to serve too large an area with too small a fleet can result in poor service for everyone. Several systems have floundered as a result of overextension. It's better to start with a small area and expand if possible.

RIDER/VEHICLE MISMATCH

Riders and vehicles may be mismatched in many ways: A California survey showed that the elderly tended to view taxis as a prestigious form of transportation, and tended to disdain buses providing the same service. On the other hand, young mothers preferred buses to taxis for shopping. Several systems reported that certain user groups (notably the young and old) proved incompatible in the close confines of a taxi-sized vehicle.

INADEQUATE INFORMATION MATERIALS

Preliminary information should not only advertise the coming of the paratransit system, but should also tell potential riders how to use the system.

PINPOINT ARRIVAL PREDICTION

The user should be supplied with a range bracketing the expected arrival time, rather than with a precise arrival time. This policy greatly enhances the perceived reliability of the system.

POOR CONTROL ROOM DESIGN

In manually-controlled systems, trip tickets and vehicle location information should be visible to the dispatcher at all times.

4.0 IMPLEMENTATION

4.1 Overview

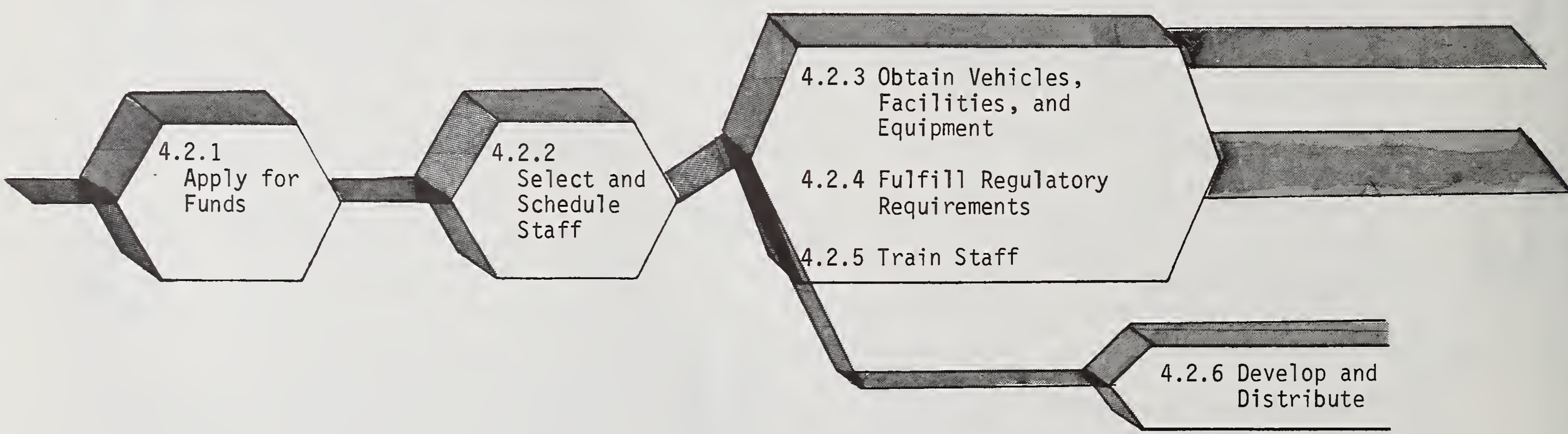
4.1.1 Functional Tasks

Implementation is generally defined as the process which begins with the purchase of equipment and the commitment of operating staff and continues to the initiation of revenue service. The implementation phase consists of the functions sketched below, and includes staff selection and training, funding approval, vehicle and equipment procurement, licensing, marketing, information system design, and pre-testing.

4.1.2 Timing

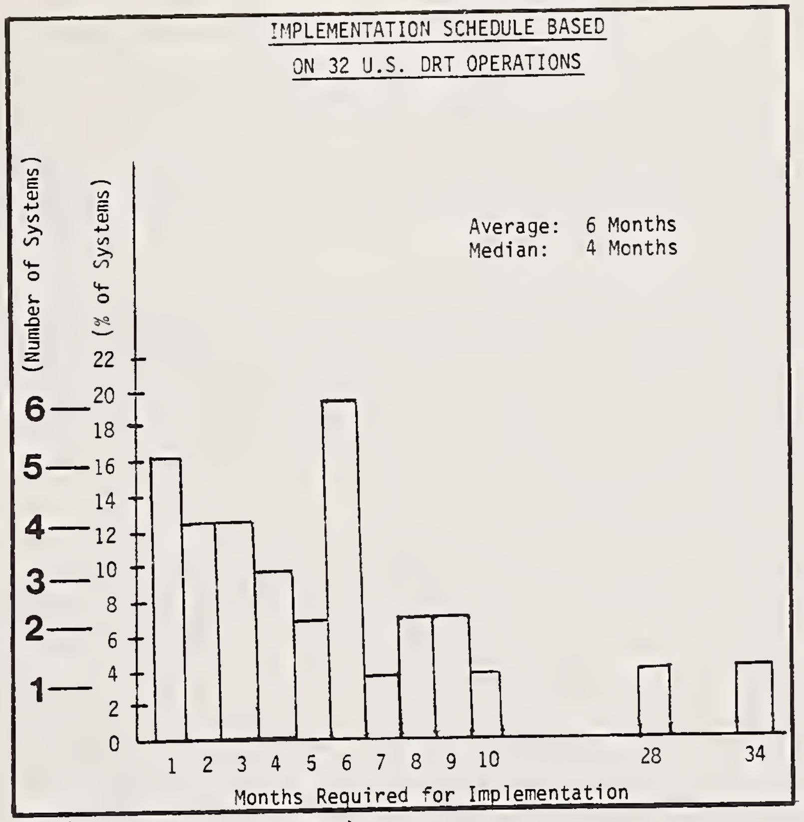
Existing demand-responsive transit system experience in the United States indicates that the implementation stage can take from one month to over two years. Twenty-four of the 32 systems reporting, or 75%, were able to complete the implementation phase in six months or less. The quickest implementation times were reported by state-supported systems in Michigan and California. where implementation times averaged less than two months as compared with an average of six months for all systems reporting.

The Canadian Dial-A-Bus Manual (Reference 4) reports implementation times ranging between two and six months, with an average of four months.

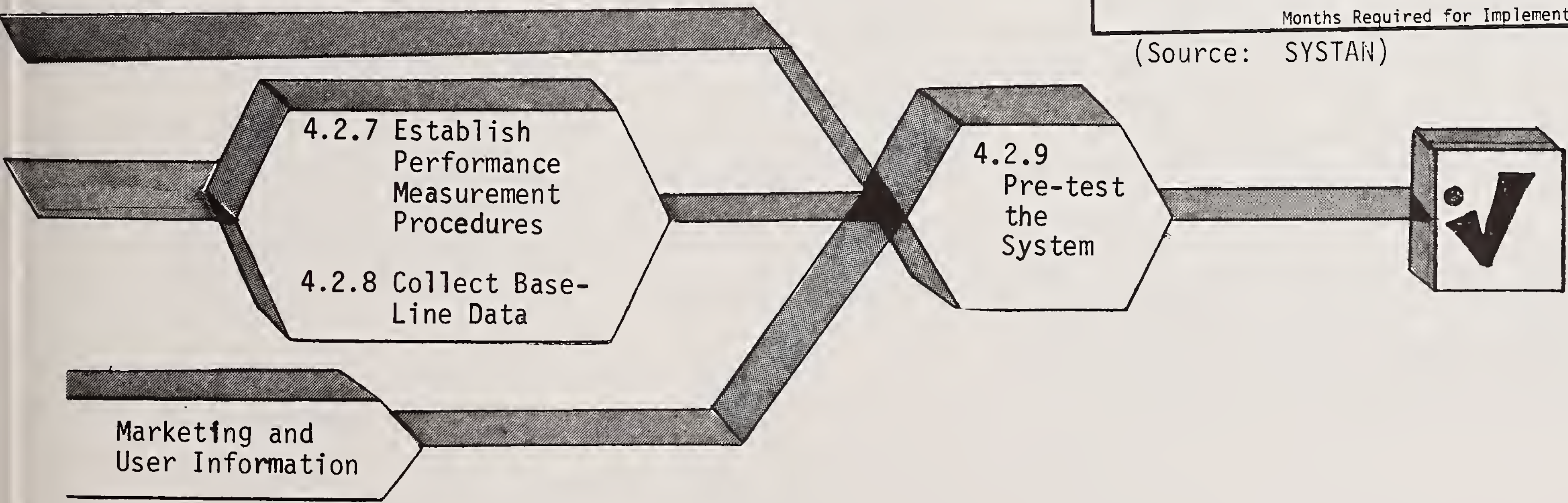


The three most critical tasks governing the timing of the implementation phase are: (1) funding approval; (2) vehicle and radio equipment procurement; and (3) Federal Communications Commission (FCC) licensing.

The first of these tasks, applying for and receiving funds from federal, state or local sources, may ultimately determine the entire implementation schedule. As explained in Section 4.2.1, the time between the initial application for aid, the first implementation task, and service initiation may be at least ten months if federal capital grants are sought. Both of the systems in the accompanying graph that required the longest implementation period (over two years) relied on federal grants. In general, the closer the funding source is to the community, the shorter the time will be between applying for and receiving aid.



(Source: SYSTAN)



SCHEDULE

4.1.3

Experience also indicates that a considerable amount of lead time is required when ordering equipment. Vehicle procurement is likely to be the most lengthy and least predictable process. Delivery of new vehicles may require anywhere from two to six months; radio equipment procurement may require two to three months, and FCC licensing approximately four months.

Funding, equipment and licensing tasks need to be carefully monitored to adhere to schedule. The sequence of tasks presented below can be tailored to meet individual community needs and used to monitor the implementation task.

4.1.3 Implementation Strategies

Practitioners generally recommend that new systems start small and expand incrementally as demand patterns become clear and personnel become more efficient. This "learn by doing" strategy is not always feasible. Political concerns for equity may dictate that all areas of a jurisdiction receive comparable service. Nonetheless, initiating service all at once over a wide area can result in poor performance and endanger the entire system. One of the causes of the failure of the Santa Clara Personal Transit (Dial-A-Ride) system was the fact that the system started in 18 zones at the same time. This meant that all estimating errors in demand and control room staffing were compounded many-fold. In contrast, the Rochester system began in one suburb (Greece), with the intention of expanding to six or seven additional areas. Within Greece itself, service began in a 9.6 square mile zone, and grew in four stages to a 15.2 square mile zone. The system later contracted as new fixed routes were established which better served the demand identified through the Dial-A-Bus experience.

IMPLEMENTATION STRATEGIES REPORTED BY 42 SYSTEMS

	General Market			Target Market		
	Total	DAB	SRT	Total	DAB	SRT
Small fleet	12	10	2	10	10	
Small service area	6	6		7	7	
Minimum advertising	8	7	1	7	6	1
High fare (to constrain demand)	1	1		2	2	
All at once	12	7	5	6	5	1
Incremental approach	7	6	1	9	9	
Other	2	2	—	1	1	—
Total	48*	39	9	42*	40	2

No answer = 51 Answers = 42

*Some systems reported more than one strategy.

(Source: SYSTAN)

(A) Past Experience

A strategy of starting a full-blown areawide service all at once may result in an overwhelming passenger response before the system has been debugged. This leads to confusion, poor service and discouragement that can have far-reaching effects. It is generally better to ease into the service to gain useful experience before exposure to the public becomes too great. The facing exhibit shows the start-up strategy of several general market and target market services. Fully one-quarter of these services elected to begin operation with a small fleet, with the option of adding vehicles as demand rose. Capital investment was minimized and only a few drivers needed to be hired. It is almost always easier to expand than to reduce service.

Fifteen percent of the services listed in the exhibit began with a smaller area than they eventually hoped to serve. So long as personnel were learning, service was concentrated in the smaller area. As the team developed proficiency, the service area was expanded with no loss in service quality. Twenty percent of surveyed systems started with little or no advertising. An additional fifteen percent used a combination of incremental approaches. Of the 90 services polled, only 18 started up all at once. Six of these were shared-ride taxi services that used existing vehicles and drivers. The other twelve were dial-a-ride services. Most were small.

(B) Rules of Thumb

Rules of thumb for formulating service strategies include:

- Keep capital investment low. Whether private or public, the survival of the system is subject to many threats. If the system is private, the marketplace is a threat. If it is public, the system is subject to political vagaries. High costs threaten both system categories.
- Public information must be clear. Be sure that adequate information is available so that users are able to thoroughly understand the service.
- Provide for public feedback. With service inauguration, set up a procedure for regularly testing customer reactions and soliciting suggestions. Give all suggestions serious thought.
- Use manual dispatching. Manual dispatching should be used before computerized dispatching schemes are even considered.
- Carefully test all aspects of the service in advance. Double-check public information, signs, and service boundaries. Develop a strategy for treating requests that are outside of the service area.

4.1.3

- Select evaluation criteria. Before service initiation, select evaluation criteria and stick with them. Also, prepare the test plan in advance.

- Set goals before service begins. Revise the goals if necessary, but don't kid yourself or others by shooting for unreachable goals or raising unfounded expectations for the service.

- The level of media marketing during service initiation should be chosen with care. Overselling the system can lead to more initial demand than the system can accommodate. It has been suggested that advertising should be withheld until the system has been proven and is working without problems. News articles on the system will often provide sufficient media coverage initially; this should be supplemented with user information materials available at selected locations and upon request. Since many users learn of new services by word of mouth, ridership will grow without advertising. When the system has been debugged and management feels it has excess capacity, media advertising is appropriate.

4.2 Procedures

4.2.1 Apply for Funds

Review the selected funding options identified in Section 2.2.5. The revenues and cost estimates developed in the design process (see Section 3.2.11) will provide a basis for determining the magnitude of the funding assistance needed. Fleet, facility and capital equipment requirements will determine basic capital assistance needs, while a comparison of operating revenues and costs will indicate the size of any ongoing subsidies.

Specify sources and amounts of assistance required. The approximate date that service will begin operation should be based on the date that funds will be available. If federal capital grants will be used, expect at least ten months between initial application for funds and service implementation. UMTA's method of paying funds only after grants have been approved has caused some systems to be delayed or forced to borrow or transfer funds from other accounts to pay contractors.

It is more difficult to estimate the time lapse for state and matching programs for dial-a-bus service because they are relatively new and varied. However, Michigan's program has demonstrated that exceptionally rapid implementation is possible with state funding. Exclusive use of local funding sources will probably allow services to start up as soon as the vehicles and equipment arrive.

Follow the instructions for completing capital and operating application forms (References 155,152,156 and 154); SCRAPS Section 7.3.1 includes a sample federal assistance application form with supplemental budget forms and instructions and a sample state assistance application form (California). If help is needed in completing these forms, contact the state or regional body for assistance.

In general, applying for federal monies entails submitting a pre-application form (SCRAPS 7.3.1) to UMTA that briefly describes the service and the amount of money needed. UMTA then evaluates the pre-application, checking to see that all planning requirements have been met. The subsequent final application will require detailed estimates of equipment, vehicles and facilities, costs and benefits of the service to the community, and its relationship to other modes of transportation in the area.

Separate bank accounts may be desirable if there is more than one source of funding. For example, if your system is funded by UMTA Section 3 money, for capital expenses, and by a CETA grant, which is usually restricted to paying employee salaries, you may want to keep the monies in separate accounts for easier bookkeeping. Of course, if funds are not restricted, a single account will suffice.

2.2.5
Funding Sources

7.3.1
Federal
Assistance
Forms

4.2.2 Select and Schedule Staff

A community that will be hiring and training its own paratransit personnel should be aware of any special considerations (such as union contracts, community hiring practices) to be met. Programs funded through Community Development Block Grants may restrict employment to city or local residents. In some areas, labor agreements have required that all work assignments be bid through the seniority system. In other areas, hiring preference has been given to bilingual applicants.

If the community decides to contract out for service, it should make sure that these considerations are clearly understood by the consultant or responsible agency.

(A) Staffing Plan Refinement

The staff selection process is one of the most important implementation steps. Once job descriptions, staffing plans, labor assignments and personnel arrangements have been assembled, they can be analyzed and refined on the basis of advisory council reviews and cost constraints.

The interviewing and hiring should be done at the same time that the equipment and facility arrangements are being made. Ideally, these functions will be timed so the staff can begin training shortly after the equipment arrives. The schedule time lag for beginning the training process will also enable prospective employees to give sufficient notice to their current places of employment.

(B) Select Staff

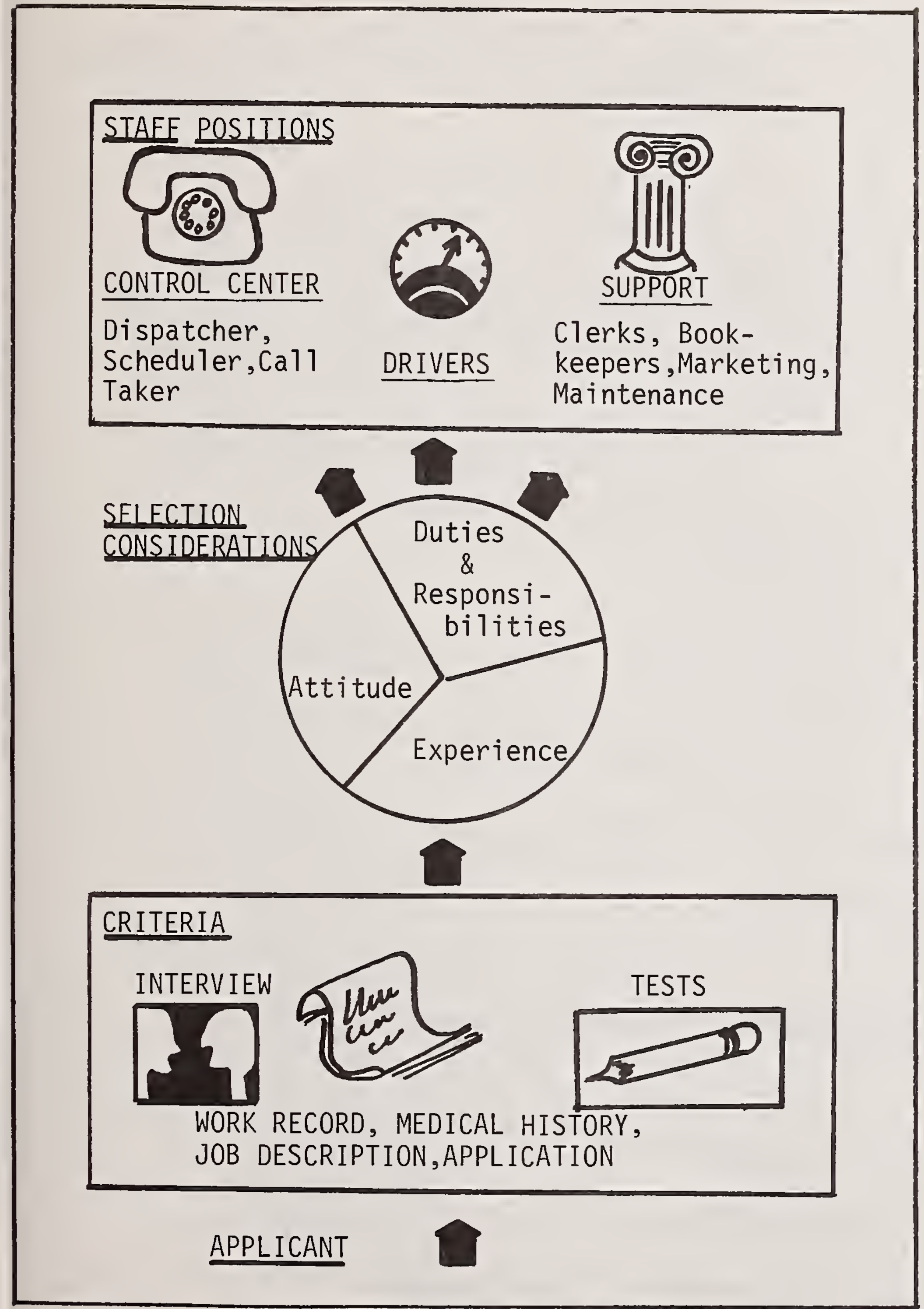
"Of primary importance in new service initiation is to have dedicated, adventurous operating staff, rather than staff which meets arbitrary standards of education and/or experience." (Reference 43)

Advertise the available positions through local newspapers and employment agencies. Include portions of the job descriptions and the address or telephone number of the contact agency or person. The Comprehensive Employment and Training Act (CETA) can also provide a potentially inexpensive source of employment. Check city and county participation in such programs.

Applicant evaluation should be based on:

- Previous employment record.
- Regulatory Requirements. Medical examinations may be required by the state. Note any particular medical or physical limitations which would inhibit or restrict the applicant's performance, particularly the vehicle drivers. Note any additional requirements such as valid driver's or chauffeur's license and FCC operator's license. Driver applicants should have a driving record clear of any accidents or violations.
- Interview. The applicant's attitude and ability to meet the system's needs, though difficult to specify, is nevertheless extremely important. Generally, the interview should explain the expectations and problems of the job to the applicant, and should also reveal to the interviewer the applicant's attitudes toward dealing with clients, promoting the service, handling pressure and last-minute changes, as well as familiarity with the service area.

STAFF SELECTION PROCEDURE



(Source: SYSTAN)

If split shifts or part-time positions are anticipated, note hours the applicant is available and any preferred hours or schedule.

The manager should try to keep the screening/interviewing process as objective as possible, while acknowledging that there are subjective elements in the selection of good employees that cannot be easily identified. Keep in mind that paratransit service entails a great deal of personal contact; try to select employees who can work well together and with the public.

Design an organizational chart to clarify the lines of authority and communication within your system.

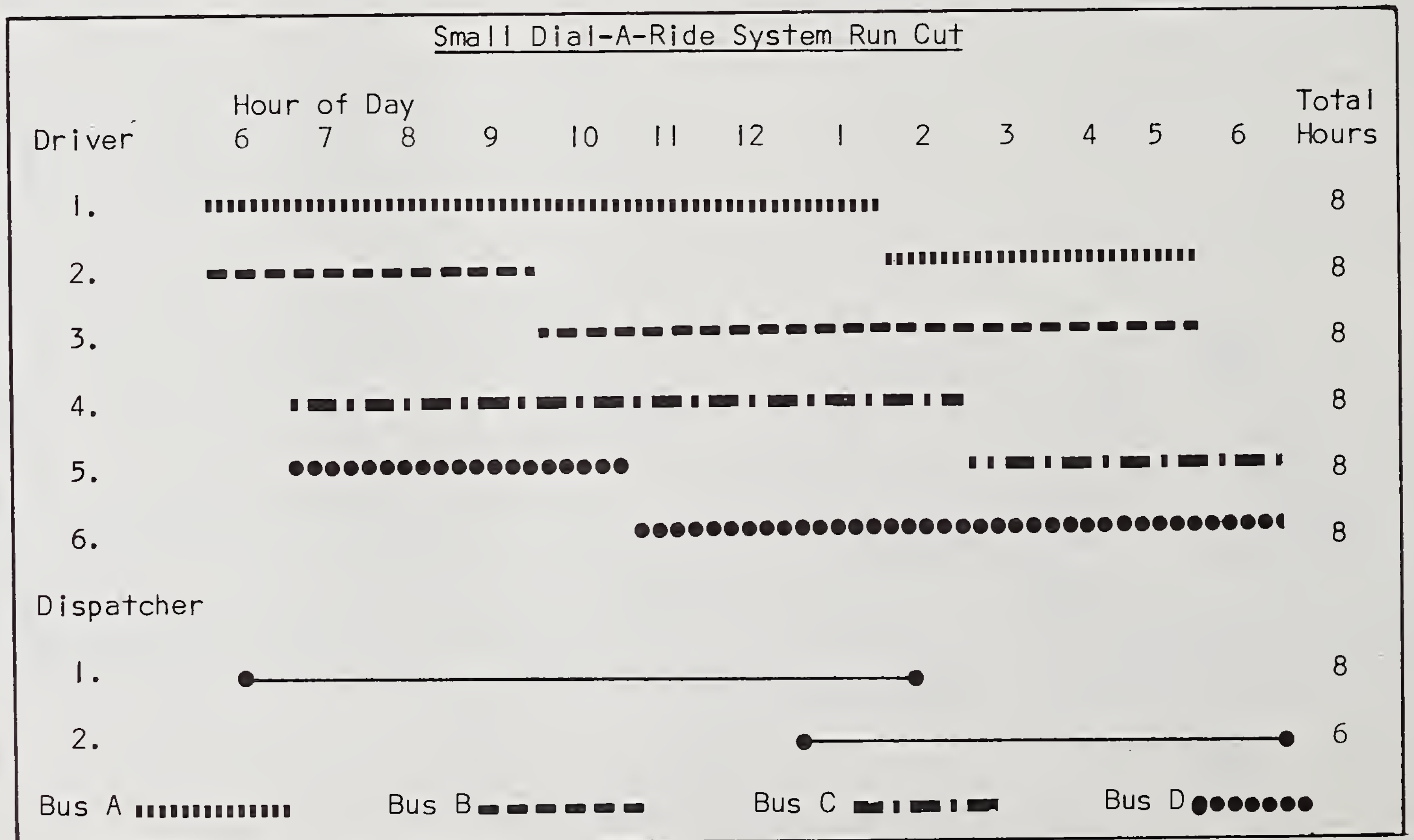
(C) Personnel Scheduling

(This section is based primarily on data initially compiled from several dial-a-bus systems by the Huron River Group, Inc. and Missouri Transportation Associates, Reference 43 .) Staffing driver runs and controller functions is a task whose complexity rises rapidly in relation to system size. Small operations are usually based on personal negotiations. Larger stand-alone and integrated systems require more intricate run designations and standardized assignment practices. If a small system expects to grow significantly, it can avoid awkward growing pains by using standardized procedures right from the start.

(i) <u>Small System Scheduling.</u> Driver shift changes can take up to half an hour, and thus should be staggered across relatively slow demand periods. DRT ridership tends to be fairly evenly distributed between 10:00 A.M. and 4:00 P.M., although traditional work-trip peaks may develop. Early afternoon call volumes tend to be heavy and randomly distributed. Hence, controller work shifts should include long overlap periods to preserve continuity and to provide back-up and assistance during peak periods.

The scheduling procedures described below and illustrated in the exhibit are based on a four-bus fleet, operating weekdays from 6:00 A.M. to 6:00 P.M., but can be applied to most small, non-unionized systems.

- Determine the full-time equivalent necessary to meet your vehicle-hours per week commitment. (Four vehicles X 12 hours X 5 days = 240; 240 vehicle-hours ÷ 40 hours per week = equivalent of six full-time drivers.)
- Lay out these vehicle-hours graphically in blocks of 8 and 4 hours (or whatever fraction is appropriate).
- Overlay the potential out-of-service situations such as lunch, driver switches, morning show-up, and deadheading time.
- Repeat Steps 2 and 3 iteratively until the mix of straight shifts, split shifts, and part-time work are satisfactory and overlapping out-of-service situations are minimized.
- Determine the dispatching, administrative and support assignments. (Twelve hours can be divided 8-4 or 6-6 with overlap.)



(Source: KCMR, Reference 43)

Several variations on the basic theme reflecting different organizational arrangements are described below:

- Driver and dispatcher positions can be combined in several ways. For example, a split shift of four hours each driving and dispatching is possible. Eight-hour dispatching and driving shifts on alternate days spreads the higher-tension dispatching work among more people and provides back-up dispatching capabilities for the system.
- Part-time work periods can be left to an extra board rather than being assigned.
- If lunch periods are assigned and carefully spaced, a single driver can cover all lunch periods by substituting in the first breaking driver's vehicle, after which each breaking driver will turn the vehicle over to the driver coming off a lunch break.
- If weekend service is included, or added, several options are possible:
  - A part-time weekend crew;
  - Rotate weekend duties on an overtime basis;
  - A weekend crew whose alternate days off during the week are covered by full- or part-time drivers with run assignments which vary day-by-day to cover all of the weekend crew's normal runs; or
  - Delegate weekend hours to the extra board.

Employee assignments can be based on seniority preferences, or initially determined by the manager, with revisions and re-bidding permitted periodically.

(ii) Large and/or Integrated System Scheduling. The basic principles outlined in the small system example above also pertain to larger operations, with the combinations of choices becoming increasingly more complex. Larger systems also usually face additional union labor constraints, such as the proportion of split-shift runs allowed (see exhibit).

Automation of the run-cutting and scheduling process (RUCUS) may be applied to systems of 50 or more vehicles in mixed demand-responsive and fixed-route services. RUCUS maximizes the scheduling objectives (e.g., minimal cost and maximum number of full-time shifts) by looking at the entire system, rather than attempting to work on a piecemeal, route-by-route basis.

POTENTIAL UNION OPERATION

LABOR CONSTRAINTS

Daily Limits

Driving hours, maximum allowable
Pay hours, minimum guarantee
Swing time, minimum
Relief period frequency
Spread time, maximum allowable
Spread time, maximum paid at straight time
Work day, standard at straight time

Weekly Limit

Work week, maximum time for straight time pay

(Source: Transportation and the Disadvantaged, Reference 135)

4.2.3 Obtain Vehicles, Facilities, and Equipment

Conventional demand-responsive transit experience indicates that considerable lead time is required in obtaining equipment. In addition to a one- to two-month period to receive UMTA specification approval (if federal funds are used for capital), new demand-responsive vehicles can be expected to require two to six months for delivery, and the radio equipment approximately two to three months. If these major procurements must be conducted competitively, in compliance with Federal capital grant requirements, equipment receipt may be delayed an additional one to two months (Reference 36).

(A) Solicit Bids

(i) Identify available small vehicle and equipment manufacturers, regional distributors or local dealers. Local dealers may be adequate and desirable for standard automobile, van and equipment procurement. (See Section 3.2.8 and 3.2.9 for Checklist; and SCRAPS 1.1 for vehicle suppliers.) A decision must be made as to who will perform any necessary equipment modifications, such as van conversions (manufacturer, local dealer, or operator) and whether or not the initial pool of spare parts is to be ordered from the supplier.

(ii) Follow the municipality's established bidding procedures or, if no precedent exists, consult a similar agency for guidance. Send specifications and request bids from known suppliers. A "Notice to Bidders" advertisement may also be placed in transit industry trade publications, such as Passenger Transport. Denver, Colorado initially solicited general guidelines relating to vehicle size and accessibility, with a subsequent bidder's briefing further detailing the Handyride vehicle specifications. To give bidders some leeway on non-essential items, operators may request tenders to outline any special features or the extent to which their product differs from specifications.

Obtain written guarantee and expected delivery and payment schedule for each product. Headaches and delays, especially regarding warranty coverage, can occur for converted vehicles and equipment for which the assembler does not manufacturer the majority of parts (Reference 4).

(B) Evaluate

(i) Assess technical features and note any specification variations.

(ii) Compare equipment and total vehicle life cost, including estimated maintenance and repair costs with the initial price. Identify future replacement availability. For vehicles, estimate the dollar cost per mile or per hour for each competing model. Rate the comfort, image, safety and overall acceptability of each vehicle.

(iii) To facilitate radio equipment maintenance, consider purchasing all components from one supplier who can handle the responsibility for the entire system.

(iv) Consult with existing operators that are familiar with the equipment, particularly the vehicles in question. Do not sacrifice performance and quality in an attempt to reduce initial costs. Experience shows unreliable equipment can cause maintenance and operating costs to mushroom and riders to disappear.

3.2.8 Vehicle Selection
3.2.9 Communication Equipment Worksheet

1.1 Vehicle Characteristic Sheets

(v) Coordinate payment schedule with the federal, state or local government agency covering the capital expenses.

(C) Award

Select best value and award contract. Do not award vehicle conversion contract, if done by party other than purchase source, until vehicles are delivered to determine to what extent they meet agreed initial specifications.

(D) Alternative Arrangements

Michigan demand-responsive transit systems attribute their fast and successful implementation program to state leadership and financial support. Arrangements for regionally-pooled vehicle purchases and shared radio channels during initial operation facilitates capital equipment acquisition with or without federal dollars. Bulk purchases not only take advantage of economies of scale, but also reduce the amount of paperwork required.

Basic radio equipment can be obtained off-the-shelf with comparatively short vendor lead times. Telephone equipment is usually leased from local telephone companies.

(E) Auxiliary Equipment, Furniture, Control Aids

The acquisition of control center and office equipment is fairly straightforward. Standard office desks, file cabinets, and furniture can be obtained locally.

While awaiting vehicle and equipment arrival, develop maps and aids for training and implementation--much of the information collected when surveys of existing conditions and candidate sites were being identified and selected (See Planning Sections 2.2.3 and 2.2.6), should be useful. Additional windshield surveys and walking tours of the service area are advised to identify all major and minor through- and cross-streets, residential, commercial, and industrial configurations, and any other special characteristics which may have been previously omitted.

Prepare an enlarged wall map for controllers to use in assigning requests and tracking vehicles. Color-coded magnetic map markers and basic office supplies should also be purchased at this time. Print enough smaller hand-size (e.g., 8" X 10") service area maps to distribute to each employee and place in each vehicle, plus some "extras." Although maps used in the marketing effort should not be as detailed as these, they can be developed from the same basic information. Also obtain some maps from local service stations or Chambers of Commerce of the entire region or community and clearly demarcate the service area boundaries. This will provide the "bigger picture" and can help to orient trainees to the specific service area.

Refine the forms designed for internal operations (originally outlined in Section 3.2.10), to meet the demand-responsive system's operating, management, accounting and performance measurement information needs. Sample forms are included in Appendix A-11, and the following checklist and Worksheet may provide some additional helpful guidance.

P
2.2.3 Existing Conditions Survey
2.2.6 Identification of Candidate Sites

D
3.2.10 Scheduling and Dispatching Forms

Go to
Appendix A-11 Sample Operating Forms

4.2.3

ADDITIONAL EQUIPMENT/FURNITURE/AIDS + WORKSHEET

	Unit Cost ($)	Amount	Total Cost ($)	Source	Delivery Date	Comments
Internal Operation Forms						
- Order Cards -Permanent booking -Advance reservation -Immediate request						
- Dispatcher Logs						
- Driver Logs						
- Vehicle Inspection Sheets						
- Vehicle/Maintenance Summaries						
- Timesheets/Payroll Records						
Maps						
- Magnetic Wall-Size						
- Smaller Service Area						
- Marketing Campaign						
- City/County						
Office Supplies						
- Magnetic Map Markers						
- Stationary Items						
- Furniture						

(Source: SYSTAN)

(F) Delivery

When equipment and vehicles arrive, inspect for compliance with agreed specifications. Notify supplier in writing of any discrepancies or missing items. Variations may justify refusing delivery, adjustment in price or immediate redress by the supplier. This decision must be weighed against delaying the initiation of service. Test and debug all equipment.

(G) Make Facility Arrangements

Decisions to share, lease or construct the control center, office, maintenance facility and transfer stations should have been made in the design stage (see Section 3.2.13).

Site selection and agreements for obtaining such facilities must now be finalized. City attorney or city representative should assist in drawing up or reviewing contracts. Specify dates for initial occupancy, and coordinate equipment delivery and training program accordingly. If modifications or remodeling of structure are necessary, contact building contractors and readjust schedule.

Contact local utility (electric, gas, water) companies and request service.

D 3.2.13
Facility Design

4.2.4

4.2.4 Fulfill Regulatory Requirements

The accompanying checklist (developed from Reference 4) summarizes some of the key regulatory factors to be cleared before project initiation.

Most of the institutional questions should be settled or close to resolution by now; this step then becomes a matter of fulfilling requirements:

°Obtaining insurance;

°Registering vehicles;

°Undergoing safety inspection;

°Paying fees; and

°Obtaining clearances and permits.

REGULATORY CHECKLIST

Clarifications on:	Questions
Paratransit service	° To be regulated as: - A taxi - A bus - Both - Neither
Service operations	° Any conflicts with local ordinances ° Insurance coverage ° Jurisdictional overlaps ° Labor union support ° Any conflict with existing franchised operators ° Need for certificate of public convenience and necessity

Clearances	Area of Concern
Local permits Zoning clearances	° May be needed for building and antenna structures
Traffic laws	° May need change for access to certain streets or non-standard turning movements
Existing franchises for transit in service area	° Examine for possible conflict ° Check possibility of shared facilities or fare structures
Franchise under management contract or private operator	° Specify: 1. Number of vehicles and personnel in service 2. Area to be served 3. Hours of operation 4. Fleet maintenance 5. Financial arrangements ° Allow flexibility to modify service
Labor unions	° Clarify work rules
Vehicle license for public service vehicle	° Proof of adequate insurance ° Safety inspection
Radio license and telephone regulations	° Mobile units and control center operation
Operator licenses	° Requirements for use ° Drivers

(Source: Canadian Dial-A-Bus, Reference 4 and SYSTAN)

4.2.5 Train Staff

While the staff is being selected, the training program and schedule should be developed and refined.

(A) Schedule

An overall training schedule should be prepared defining the subjects covered: the reference material; visual aids; methods of presentation; instructors needed; handouts; and examination schedule.

Each job position may need a specific training schedule to cover special job requirements. The training program need not be repetitive for those trainees with experience. Make use of these resources; their experience can be valuable to less experienced employees. A list of recommended training requirements is shown in the exhibit.

A two- to four-week training period should be comprised of both classroom and simulation exercises. Section 4.2.9 , System Pre-Testing, suggests a range of possible simulations.

Plan ahead--coordinate hardware installation and manufacturer's instruction sessions (especially recommended when installing complex computer controls) to fit into training periods. Recheck anticipated delivery dates for vehicles, radio and communication equipment.

(B) Training Program

Preliminary training should be standard for all employees, during which time individual interests and capabilities may become evident. If possible, delay assigning specific jobs until midway through the training program; this will allow trainees who express interest in certain functions, such as dispatching, to have the opportunity to undergo training. Stress the fact that, although control room and driver positions require different skills, both are essential parts of the total operation.

Santa Clara County's training program (developed by LEX) and existing system experience suggest these guidelines:

- Limit classroom presentations to one hour maximum for any subject.
- Simulations should be seven hours maximum, with one hour for critique.
- Include early morning and late evening simulations.
- Stress map reading for drivers and controllers.
- Stress public relations in all groups.
- Schedule question-and-answer sessions daily to assure that the information is understood.
- A final wrap-up session can cover any peripheral issues. Assignment to or selection of runs and schedules can be done at this time.
- Develop or order training equipment outlined in the preliminary training plan (Section 3.2.15).

I 4.2.9
Pre-testing the System

D 3.2.15
Staff and Training Plan

GENERAL TRAINING REQUIREMENTS FOR TRANSIT SYSTEM OPERATING STAFF

JOB CATEGORY	REQUIREMENT															
	INTRODUCTION ORIENTATION	GENERAL OPERATING	CONDUCT ON THE JOB	PERSONNEL POLICIES	DRIVER TECHNIQUE MANEUVERS	DISPATCH PROCEDURES	RADIO PROCEDURES	TELEPHONE PROCEDURES	MAINTENANCE PROCEDURES	SUPPORT STAFF PROCEDURES	SAFETY RULES	FIRST AID	EMERGENCY PROCEDURES	MISCELLANEOUS PROCEDURES	AREA AND MAP FAMILIARIZATION	SIMULATION
DRIVERS	■	■	■	■	■	●	■	●	▲	●	■	■	■	■	■	■
DISPATCHERS	■	■	■	■	●	■	■	▲	●	●	▲	■	■	▲	■	■
SCHEDULERS	■	■	■	■	●	■	▲	■	●	●	●	▲	■	▲	■	■
TELEPHONISTS	■	■	■	■	●	▲	▲	■	●	▲	●	▲	■	■	■	■
MAINTENANCE	■	■	■	■	▲	●	●	●	■	■	▲	■	■	▲	▲	●
CLERICAL	■	■	■	■	●	●	●	▲	●	■	●	▲	■	▲	▲	▲
MARKETING	■	■	■	■	●	●	▲	▲	●	■	●	▲	■	■	▲	▲

■ MANDATORY
▲ RECOMMENDED
● OPTIONAL

(Source: SYSTAN)

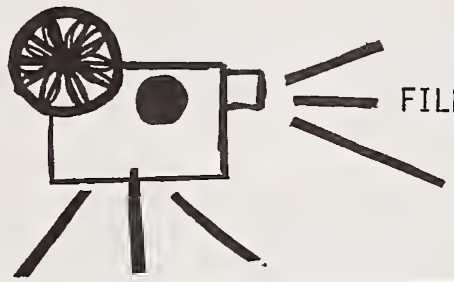
Design your own operations manual or handbook to facilitate and supplement the training sessions. Each employee should receive a manual outlining the basic structure of the training program; lectures/sessions should be highlighted, not duplicated in text; space for notes, comments and questions should be included in margins; and loose-leaf format allows appropriate sections to be inserted/deleted according to employee's needs. The Michigan DART Program Operations Manual is an excellent training reference (Reference 51).

(C) Orientation

All new employees must be introduced to the concept of demand-responsive service. Present an overview of existing systems or a limited historical account of paratransit operations (see System Characteristics or Introduction). Reference to existing systems can also be made using available slides and films. The novelty of the concept will undoubtedly cause some confusion in many employees' minds, and an attempt should be made to deal with any misunderstandings; allow time for discussion and question-and-answer periods.

Conduct tour of control center, garage and maintenance facilities, and driver areas. Include all staff members in sessions dealing with the overall scope and basic operation of the service: Cover the zone or route concept, reservation and dispatching procedures, stops, walk-on boarding procedures, fares, etc.

Flexibility means sharing responsibilities during periods of peak demand, or possibly providing additional personalized services (e.g., helping the elderly with their groceries). Flexible service can also mean additional responsibilities are carried by each employee.



FILMS

"TRANSIT OPTIONS FOR SMALL COMMUNITIES"

29 Minutes, 16mm, Color 1976

This film documents four innovative public transit concepts in four small cities (population under 50,000): Fixed-Route in Westport, Connecticut; Route Deviation in Merrill, Wisconsin; Dial-a-Ride service in Merced, California; and Subsidized Shared Taxi in El Cajon, California.

Together these examples represent a spectrum of public transportation alternatives appropriate to small communities. The operation and service features of each system are shown and narrated by the local transit officials. In each city, community attitudes toward the service are reflected in interviews with local citizens.

Loan: National Highway Institute
or
Broadcast/Audio Visual Division
Office of the Secretary (OST) (S-83)
Department of Transportation
Washington, D. C. 20590

"IT'S LIKE BEING PEOPLE"

13 Minutes, 16mm, Color, 1976

The Denver Regional Transportation District (TRD) released this film on the handyRide program which offers the first service of its kind in the Nation to handicapped and elderly persons. The film reflects RTD's first year of experience with the special subscription bus service which transports more than 1,800 handicapped and elderly persons weekly to work, school, medical services and shopping areas.

Loan: National Highway Institute
Purchase: Denver Regional Transportation District (RTD)
Attn: Ms. Kathy Hodges, RTD Library
1325 South Colorado Boulevard
Denver, Colorado 80222
(303) 759-1000
Cost: $80

Part 3
System
Characteristics

Go to Part 1, INTRODUCTION
Paratransit
Orientation

Employees of the Regina, Saskatchewan system were encouraged to assist in the evolution of the service by submitting suggestions and recommendations once the system became operational.

Adequate driver supervision requires that drivers maintain frequent contact with the control center. Thus, while each individual staff member remains responsible for his/her outlined duties, the system cannot operate effectively unless everyone works together as one interrelated unit. The degree of respect and mutual cooperation, particularly between the driver and dispatcher and between the dispatcher and calltaker, can make or break the system. Teamwork is required!

The sequencing of passenger drop-offs or the accuracy of time estimates can become sensitive issues, especially when dealing with passengers who may not understand the nature and constraints of the system. Courteous service and communication, while sometimes difficult to maintain, should be stressed in all situations to keep potential conflicts or problems at a minimum.

Display visually the chain of command between management, control room staff, drivers, maintenance crew, and office and support personnel. Introduce and familiarize staff with management. All employees should understand how to ward off and possibly avoid emergency situations by personally handling problems as they arise or by deferring to higher authorities. Small problems need not explode out of proportion when staff are well trained.

Outline employee policies and procedures. Distribute all necessary administrative forms and illustrate their use on a blackboard or overhead projector. Sample forms are included in Appendix Section 11. At this stage, the necessary skills for drivers and controllers begin to diverge.

(D) Driver Operating Procedures

Develop basic vehicle operating procedures. Classroom session review and subsequent simulated practices will facilitiate the driver's understanding of these maneuvers. Address any special service area characteristics, such as railroad crossing procedures.

The National Safety Council's course on defensive driving may be a good supplement to discussions of safety concepts. Obtain a list of congested, hazardous and/or high accident locations from the local police or safety department. Consider using available police, fire, or community service personnel to direct safety and first-aid sessions. Specific training techniques for drivers should also include simulated routing and timed test runs, using a random list of addresses within the service area. A telephone book or city directory can be used to create potential origin and destination addresses. In Regina, Saskatchewan's Telebus Service, drivers were taken to the DAB service area, given a list of addresses, and told to visit each one as though it were a pick-up or drop-off, and then return to the terminal area. Runs were timed to see how well each driver could choose a route that minimized travel time and distance.

(E) Dispatching Procedures

Outline all dispatching procedures thoroughly, including the assignment of individual service requests to routes, the communication procedure for driver pick-ups and drop-offs, and familiarize all personnel with all the necessary forms, dispatching aids and equipment.

Go to Appendix A-11
Sample Operating Forms

Demonstration runs within the community to test the system are useful training, as well as good publicity. Radio equipment and codes (and computer simulation for large systems) can be demonstrated by phone-in exercises to test the dispatcher's knowledge of the service area and the capacity of the telephone-answering system. Check the amount of time required for control center personnel to record the customer information and then dispatch the vehicle. Are these figures approximately equal to your estimates? (See Section 4.2.9, Pre-testing the System)

(F) Radio Procedures

Radio communication techniques and rules for operation must be learned thoroughly by the dispatchers and drivers. Review how to set the "squelch", when to turn units on and off and how to transmit and receive messages, and 10-code. Chapter 3 of the Public Safety Communications Standard Operating Procedure Manual, published by the Association of Public Safety Communications Officers, Inc. (2503 Allender Avenue, Pittsburgh, PA 15220) is an excellent source of data on radio communication techniques (Reference 4). The radio equipment supplier should also provide a manual and a technician to familiarize the dispatchers and drivers with the equipment and voice procedures.

Remember, FCC regulations require that all radio operators and equipment mechanics be licensed, and restricts frequency use to purposes specified in the license.

Until separate FCC licensing is approved, the system may have to share radio channels with other community services. To avoid confusion, the staff must strictly adhere to the outlined radio operation procedures.

RADIO 10 CODES

	Code	Meaning
	10 - 4	Okay, last message understood
	10 - 6	Busy, stand by
	10 - 7	Out of service (lunch, break, etc.)
Must Know	10 - 8	In service at (__location__)
Must Know	10 - 9	Repeat message
Must Know	10 - 16	Make pick up at (_location__)
Must Know	10 - 19	Return to base
Must Know	10 - 20	My location is______or what is your location ?
Must Know	10 - 24	Complete at (__location_)
Optional	10 - 34	Trouble at this station, help needed
Optional	10 - 36	Correct time is
Optional	10 - 37	Wrecker needed at (_location_)
Optional	10 - 38	Ambulance needed at (__location__)
Optional	10 - 42	Traffic accident at (__location__)
Optional	10 - 43	Traffic tie-up at (___location__)
Optional	10 - 70	Fire at (_location__)
	10 - 73	Speed trap at (__location__)
	10 - 200	Police needed at (__location__)

(Source: Michigan Dial-A-Ride Manual, Reference 51)

I 4.2.9
Pre-testing the System

(G) Telephone Procedures

Because the telephone is the main artery for information flow from customers, telephone operators should be trained in procedures that will facilitate understanding, eliminate errors, and minimize the time required to handle each telephone call. Thus, telephone-answering personnel should be trained to: answer the telephone promptly and courteously, identify the service by descriptive name, speak clearly and use a minimum of words, record all required information on the proper forms, politely interrupt superfluous conversation, and maintain a friendly attitude.

Grand Huron, Michigan and Columbus, Ohio used their customer request forms and cards as an instruction aid, thus standardizing the procedure and reducing the likelihood of misplacing requests.

Some phone-handling experience is desirable prior to service initiation to give operators a feel for the type of problems customers are likely to raise. Perhaps a selected sample of potential customers could be instructed to phone in requests. In this way, customer information could be tested as well. If several controller duties are shared, trainees should progress from simply taking orders to tour building and scheduling; then use of radio equipment and aids and dispatching skills could be added.

(H) Emergency Procedures

High-quality, on-line management is necessary to deal with the variety of human- and equipment-created emergencies. Nonetheless, accident and emergency reporting procedures should be established and explained to all personnel to alleviate any additional unnecessary confusion or conflict when emergency situations arise.

Another review of chains of command and management personnel may be appropriate.

(I) Computerized System

Automated controls will require additional staff instruction, including:

- In-class and on-the-job training both prior to and during computer phase-in.
- Provisions for technical support in the control center and to assist drivers during the initiation phase of computer operation.

Automated demand-responsive transit system experience recommends that all control center personnel be eased into computer operation responsibilities. Introduce new employees to the manually-operated duties first; once they show proficiency in these areas, they can be given gradual training in the computer-aided operations, advancing from off-peak to peak hours of service.

(J) Evaluation

Trainers should note trainee capabilities during exercises. Suggested points to watch for include:

- Area Knowledge
  - Understands how to use a map (with indices)
  - Knows most address locations upon hearing

- Routing
  - Understands scheduling and dispatching procedures.
  - Aware of passenger reaction to ride time and direction.
  - Can order trips mentally.
- System Information
  - Fare structure and eligibility.
  - Service area boundaries.
  - Service days and hours.
  - How to access and use the system.
- Attitude
  - Helpful, pleasant and courteous manner.
  - Role of salesman for the system.

(Source: Huron River Group, Reference 43)

Sample driver and controller evaluation checklists are included in the Appendix 11.

(K) On-the-Job Training and Evaluation

All subsequent staff additions will need to undergo training. They can benefit from on-the-job training using actual dispatching and driver records. Some systems may want to give trainees part-time experience in several phases of operation. Procedural study classes and on-the-job training under a senior dispatcher, driver, or telephonist during the off-peak hours of operation is suggested.

Go to A-11 Driver and Controller Evaluation Checklists

Consider developing an ongoing monitoring program to evaluate individual and overall employee performance. This might include refresher courses in safety, emergency procedures, or other areas in which operating deficiencies have been detected, as well as keeping staff members up-to-date on changes in the fare structure, fleet arrangement, service area, or procedural modifications in operations. Continual staff monitoring may not only pinpoint problems or deficient areas, but also identify those members who are performing "above and beyond." Constructive criticism, coupled with positive reinforcement, can go a long way in maintaining a high level of productivity.

(L) Proficiency

Early inefficiencies can also be anticipated during on-the-job training. Learning curves can be used to approximate these inefficiencies. The Ann Arbor experience suggests that, even with a good training program, it takes approximately four to five months for new controllers to become proficient at their duties. If controller responsibilities are separated, expect the abilities necessary for dispatching to take a considerably longer time to develop than those for the order-processing function.

Similarly, new drivers may require from six to seven months to fully adapt to their responsibilities. The Ann Arbor integrated system places additional pressures and demands on the drivers and dispatchers in coordinating transfers; in a non-integrated paratransit system, the staff may become proficient more quickly. Of course, this will vary depending on the individual employee's previous experience, aptitude, capabilities and desires.

4.2.6 Develop and Distribute Marketing and User Information

(A) Scheduling Events

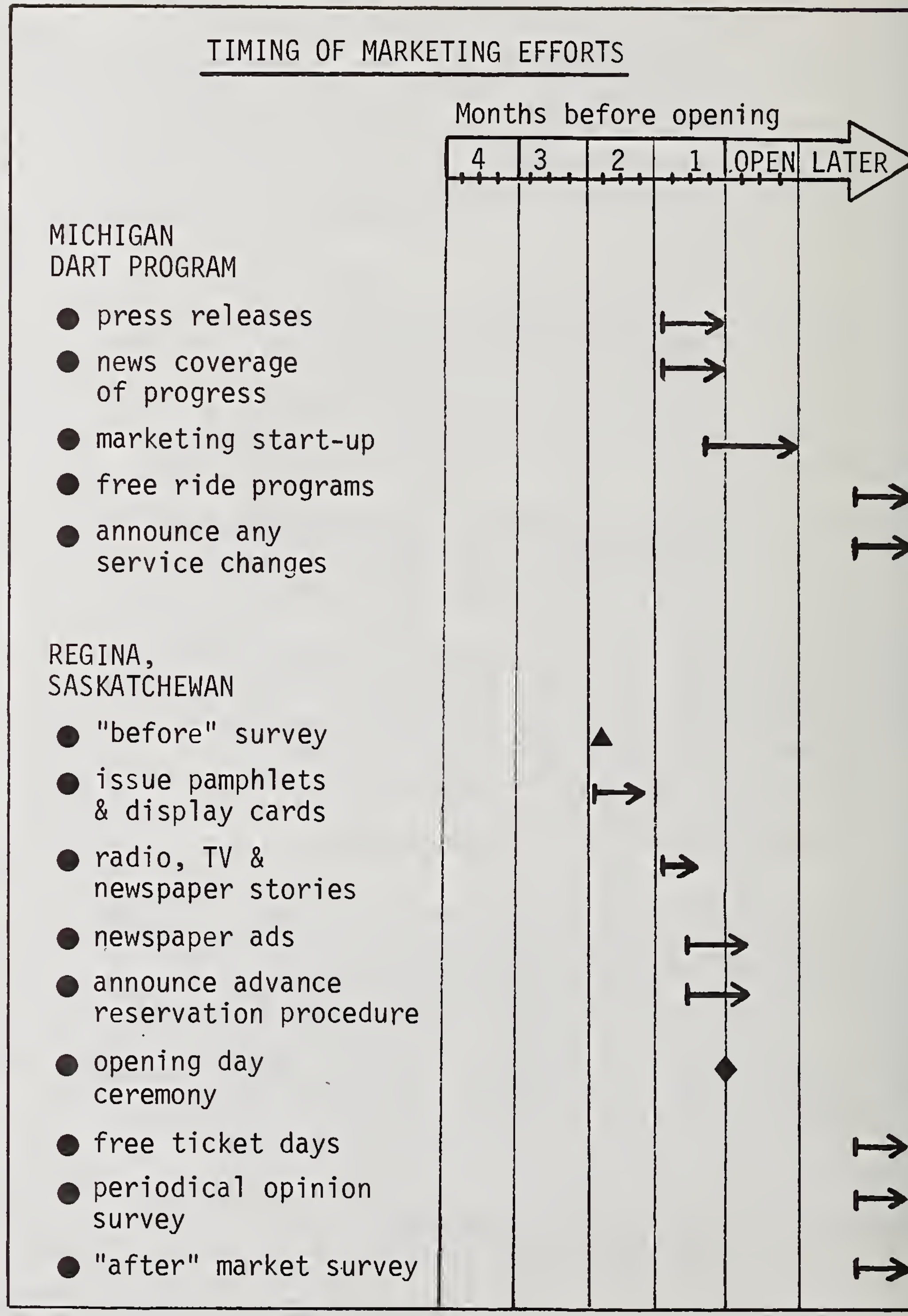
All marketing events need to be scheduled. Once the date of service initiation is known, the timing of the events can begin. Initial events, typically about one month before service, include placement of ads, press releases to the local news media, presentations to local community groups, and the final development of system brochures or direct mail enclosures. The facing exhibit shows the schedule of events for a Canadian system and a recommended schedule from the State of Michigan DART program.

Pricing promotions such as free rides, merchant discounts, etc. are generally scheduled for a later time when the system is running smoothly. Some systems have had too much demand for service to need such promotions; others have not found such promotions effective. In the Ann Arbor pilot program, the service area was too small to represent a significant advertising opportunity for merchants considering a discount program (Reference 65).

The schedule of events should remain flexible enough to accommodate opportunities which arise, such as special activities in the community. Also, promotional events may need to be curtailed if the demand for service is too great.

(B) Developing User Information

The public--both riders and potential riders--needs to have confidence that the system will be useful to them. A brief description of the service and the area served



(Source: SYSTAN)

by the system is helpful. They also need to know specific information:

- Name of service;
- Telephone number for requesting service or for system information;
- Procedures for requesting service;
- Fare structure;
- How fares are collected;
- How the system operates, including schedules, routes, stops, transfer points and locations served; and
- Transfer policy.

See System Characteristics Section 4.2.9 for additional information needed for target market systems.

(C) Presentations and Media Coverage

Community support and interest can be generated by presentations to local organizations (e.g., fraternal clubs, League of Women Voters, etc.) A speech or slide show by a project staff member can be very effective.

Media coverage takes different forms: press releases written by system staff, notification to local media of upcoming events, interviews with local officials or system personnel, special coverage of system operations, etc. Interviews and special coverage generally need advance preparation and require special arrangements to be made with the press.

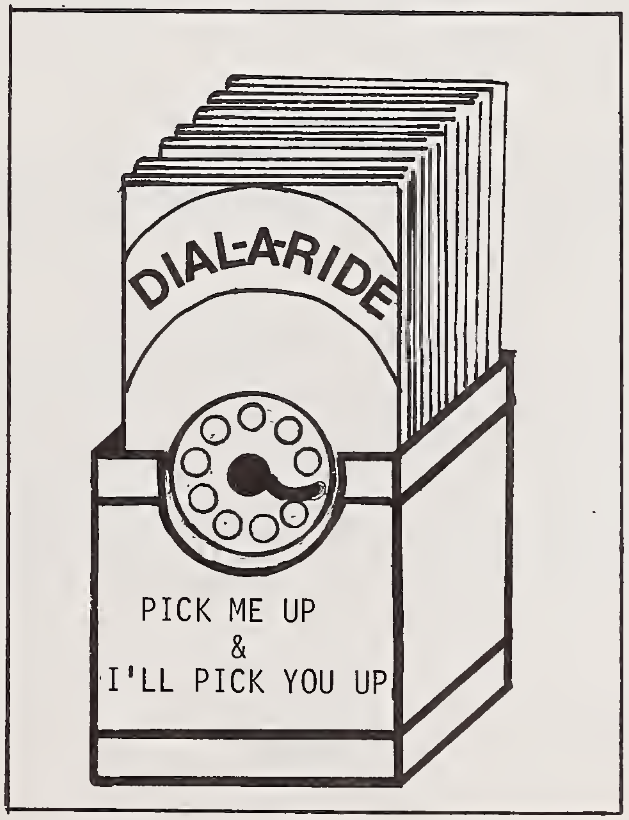
(D) Distributing Information

Possible distribution points include:

- Work locations;
- Homes;
- Hotels;
- Transportation terminals;
- On-board system vehicles;
- Transfer stations; and
- Major activity centers (e.g., shopping malls).

When system changes are made, such as new fares or new service hours, the distribution points selected need to be resupplied with updated material. These points need to be checked regularly to assure an adequate supply of materials. In Michigan, it was suggested that revised editions be printed on different colored paper and distributed before the previous material is outdated (Reference 50).

An attractive, simple holder to contain the material can be used to display the information.



(Source: SYSTAN)

4.2.9
Marketing for
Target Markets

4.2.7 Establish Performance Measurement and Reporting Procedures

A plan for monitoring system performance and recording ridership information must be developed during the implementation phase. There are several reasons for collecting system information:

- <u>To meet legal reporting requirements</u>. Legal requirements may include financial accounting and reporting to higher authorities, the public, the stockholders, and the federal government.
- <u>To aid decisionmaking</u>. Decisionmaking aids include that information which allows management to control the transit system's operation, efficiency, and effectiveness.
- <u>To assess system performance</u>. Information must be collected to measure the performance of the system against pre-established goals and objectives.
- <u>To develop system guidance for other areas</u>. If carefully collected, data from existing paratransit systems may be used to guide the creation of new systems in other areas.

In these guidelines, performance measurement connotes monitoring for reporting and system control purposes (that is, collecting the information needed to satisfy legal reporting requirements and direct the day-to-day operations of the system efficiently). The Evaluation section deals in more detail with the structured statistical approaches needed to do long-term planning and to provide system assessments of interest to other communities. Typically, the data required for performance measurement will constitute a subset of the more complete information required for a detailed evaluation. Hence, the development of plans for performance measurement should be carefully coordinated with evaluation plans.

In designing the performance measurement procedures, it is necessary to define the data elements, identify the measurement populations, and specify the following information:

- Data elements to be measured;
- A schedule of data collection and reporting activities;
- The lag between the end of data collection and the availability of information to the decisionmaker; and
- The quantity of information when sampling is used (e.g., the sample size). This in turn affects the accuracy and precision of the information.

(A) Data Management Needs

The facing exhibit lists some of the important data elements to be collected and analyzed before and after project implementation. The ongoing management use of these elements and of performance indices created from these elements is discussed in the Operations, Section 5.

E 6.0 Statistical Approaches to Evaluation

O 5.0 Data Management Needs

MANAGEMENT INFORMATION DATA ELEMENTS

SERVICE AREA STATISTICS
- Population served
- Area served
- Screenline and classification counts for traffic and transit

RIDERSHIP STATISTICS
- Ridership distribution by zone, day, week, month, season, year
- Passenger-trips/1,000 residents
- Passenger-trips/square mile
- Number of pick-ups and drop-offs
- Time of pick-ups and drop-offs in half-hour intervals

LEVEL-OF-SERVICE STATISTICS
- Wait time
- Response time
- Ride time
- Transfer time
- Telephone hold time
- Telephone service time

SYSTEM STATISTICS
- Size of operating fleet
- In-service vehicle-hours
- In-service vehicle-miles
- Total vehicle-miles
- Average length of vehicle tour (for many-to-one and many-to-few applications)
- Passengers/service mile
- Passengers/service hour
- Scheduled speed
- Operating speed
- Capacity utilization
- Number of reverse commuters
- Number of bookings by type
- Distribution of telephone requests by zone, hour, day, week, month, season, year
- Vehicle performance statistics (maintenance, fuel and oil consumption)
- Manpower requirements and schedule

FINANCIAL STATISTICS
- Capital costs
- Development costs
- Marketing costs
- Farebox revenues by route, zone, etc.
- Total revenue by fare category
- Average revenue per mile, hour, passenger
- Breakdown of total costs (administration, overhead, dispatching, wages, fuel, oil, maintenance and capital charges)
- Average cost per mile, hour, passenger

USER STATISTICS

Socioeconomic Characteristics
- Income
- Automobile ownership
- Driver's license
- Age
- Sex
- Family size
- Employment

Trip Characteristics
- Origins
- Destinations
- Walk time
- Purpose
- Modes used
- Trip lengths

Attitudes (Toward Transit and DAB)
- Convenience
- Travel time
- Cost
- Comfort
- Transfers
- Waiting time
- Complaint records

(Source: Adapted from Canadian Dial-A-Bus Manual, Reference 4)

Sources of these data elements include:

(i) Trip records specifying the ongoing destination, request time, promised pick-up time, actual pick-up time, and drop-off time for each trip made on the paratransit system.

(ii) Financial statistics including farebox revenues by route and fare category, as well as the equipment, labor, marketing, fuel, capital, and overhead costs of running the system.

(iii) Vehicle logs recording, for each vehicle, the daily number of miles traveled and hours in service, routine maintenance, emergency maintenance, fuel and oil consumption, cost of replacement parts and labor, and incidence of breakdowns or accidents. Sample vehicle logs appear in Appendix 11.

(iv) Surveys: On-board surveys can record user reactions to the system, user characteristics, market segmentation information, and trip characteristics. Household surveys can be used to reach the population of non-users. More information on surveys may be found in Sections 3.2.2 and System Characteristics Section 4.2.5; sample surveys appear in Appendix 10.

(v) Customer complaint logs: Accurate, up-to-date logs of customer complaints, comments, and information requests must be maintained. During the late implementation and early operating stages, a separate telephone number should be reserved for information questions.

Go to Appendix A-11 Sample Vehicle Logs
Appendix A- 10 Sample Survey Forms

3.2.2 Advance Surveys

(B) Management Reporting Requirements

After July 1978, no grants for UMTA Section 5 operating funds will be awarded unless the applicant or operator has installed the Section 15 Uniform System of Accounts and Records (Reference 64). The facing exhibit outlines the required expense object classes and reporting forms. A related circular (Reference 63) details recommended techniques for collecting the operating data required under this reporting system. These techniques are outlined in the following section.

(C) Sampling Procedures

UMTA has developed step-by-step procedures for collecting and reporting the demand-responsive operating data elements required by the Uniform System of Accounts and Records. In general, this system provides estimates of:

- Total passengers;
- Total passenger-miles; and
- Average passenger trip time

obtained by random sampling procedures according to specified confidence and precision levels. (Passenger-miles are to be estimated with confidence and precision levels of 95% and 10% respectively.)

The sampling selection procedure involves two steps:

1. Selecting one day each week, throughout the year, to perform the survey. Choose one day the first week of operation, then select every eighth day from that date (advance one day per week). If service is not offered that day (e.g., Sunday), skip to the next service day.

4.2.5
Target Market Surveys

PROJECT FARE: REQUIRED EXPENSE CLASSES AND FUNCTIONS

	Operations	Maintenance	General Administration	Total All Functions
Labor				
Operators' Salaries and Wages				
Other Salaries and Wages				
Fringe Benefits				
Services				
Materials & Supplies Consumed				
Fuel & Lubricants				
Tires and Tubes				
Other Materials and Supplies				
Utilities				
Casuality and Liability Costs				
Taxes				
Purchased Transportation Service				
Miscellaneous Expense				
Expense Transfers				
Interest Expense				
Leases and Rentals				
Depreciation and Amortization				
TOTAL EXPENSE				

REQUIRED REPORTING FORMS

Financial Data

- Balance Sheet Summary Schedule
- Capital Subsidiary Schedule
- Revenue Summary Schedule
- Revenue Subsidiary Schedule
- Single Mode Expenses and Functions Schedule or
- Multi-Mode Expenses and Functions Schedule
- Operators' Wages Subsidiary Schedule*
- Fringe Benefits Subsidiary Schedule*
- Pension Plan Questionnaire*

Operating Data

- Weekday Time Period Schedule
- Transit Way Description Schedule
- Revenue Vehicle Inventory Schedule
- Energy Consumption Schedule
- Transit Service Personnel Schedule
- Transit System Employee Count Schedule
- Accident Schedule
- Transit Service Supplied Schedule
- Transit Service Consumed Schedule

*Transit operators with 25 revenue vehicles or less are not required to submit these forms.

(Source: UMTA Uniform System of Accounts, Reference 64)

2. Random selection of vehicle in operation. To assure that each vehicle has the same probability of being selected:

   o Obtain enough counters (poker chips, metal labeling discs, etc.) to cover the number of vehicles in operation.

   o Write vehicle numbers on labels, assigning one to each counter. Place in sturdy container for regular drawing.

   o Mix counters thoroughly and draw one. The vehicle number on the drawn counter is the survey vehicle for that day. If that vehicle is not in service, continue to draw until a vehicle in service is selected.

   o Record selected vehicle number on Vehicle Trip Sheet.

   o <u>Important</u>: Return counters to container for next week's drawing.

While other random selection methods may be used, do not select a vehicle that "appears" to provide "representative" trips, as this may inadvertently introduce statistical biases.

(D) Collection and Reporting Procedures

Each driver of the selected survey vehicle should use the Vehicle Trip Sheet (see exhibit).

(i) Pre-Survey Procedures. Before leaving the garage, the driver should fill in:

(1) Survey date;

(2) Day of week;

(3) Survey vehicle number;

(4) Driver number;

(5) Vehicle total capacity; and

(6) Vehicle seated capacity.

(ii) Survey Procedures. The driver will record Items 7 through 11 as each passenger or group of passengers is picked up, and Items 12 and 13 immediately upon discharging riders. Or, to minimize the recording burden and improve reporting accuracy, drivers can relay the necessary information to dispatchers through two-way radio communications. It may also be possible to transcribe most of the data from the dispatcher's records, with drivers simply verifying or modifying any changes in schedules.

(iii) Post-Survey Procedures. As soon as possible after the survey day:

- Determine trip distances (Column 14) by subtracting pick-up (9) from drop-off (12) odometer reading. If odometer readings were not recorded, use map to estimate distances; however, try to avoid this relatively laborious and inaccurate process.
- Compute passenger-miles (15) by multiplying trip distances (14) by the number of passengers (7).
- Determine trip times (16) by subtracting pick-up (10) from drop-off (13) time.
- Compute passenger minutes (17) by multiplying trip times (16) by the number of passengers (7).
- Add columns for:

  (18) Total passengers in sample
  (19) Total vehicle trips
  (20) Total trip distance
  (21) Total passenger-miles
  (22) Total trip time
  (23) Total passenger minutes
- Compute capacity miles (24) by multiplying total trip distance (20) by total vehicle capacity (5).
- Compute seat miles (25) by multiplying total trip distance (20) by vehicle seated capacity.
- Perform the above tasks for each driver's survey trip sheets.

I

SAMPLE OF DRS VEHICLE TRIP SHEET

(1) Survey Date 1/4/78 (2) Day of Week Wed. (3) Survey Vehicle No. 54

(4) Driver Number 15 (5) Vehicle Total Capacity 24 (6) Vehicle Seated Capacity 17

(7) Number of Pass.	(8) Pick-up Address	(9) Pick-up Odometer Reading	(10) Pick-up Time	(11) Drop-off Address(es)	(12) Drop-off Odometer Reading	(13) Drop-off Time	(14) Trip Distance (12)-(9)	(15) Passenger Miles (7)x(14)	(16) Trip Time (13-10)	(17) Passenger Minutes (7)x(16)
16 2	1020 S. STREET	38462	1021	450 L STREET	38454	1031	1.5	3.0	10	20
3	"	"	"	380 Alaska	454	1033	2.0	6.0	12	36
11	"	"	"	Fenton & Colesville Rd	455	1035	2.7	29.7	14	154
17	506 10th STREET	456	1050	Silver Spring STATION	459	1105	3.4	57.8	15	255
1	13th & K	605	1110	Walter Reed Hosp.	610	1130	4.9	4.9	20	20
1	15th & K	606	1112	"	"	"	3.5	3.5	18	18
1	655 M ST.	606	1114	"	"	"	3.2	3.2	16	16

(18) 36 Total Passengers in Sample

(19) Total Vehicle Trips 7

(20) 21.2 (21) 108.1 (22) 105 (23) 519

(24) Capacity Miles 508.8

(25) Seat Miles 360.4

Form UMTA 2710.8 (12-77)

(Source: UMTA Procedures for Obtaining Data, Reference 63)

(iv) Recording and Accummulating Survey Results. The Vehicle Trip Sheet totals (Items 18 through 25) should then be recorded on the DRS Summary Sheet. To help evaluate performance, use "comments" column for recording any special events that might influence the survey day's service. Compute annual totals.

(v) Weekly Passenger Counts. In order to compute the annual estimates of passenger-miles and average trip times, it is essential to have a complete count of passengers for the same period covered by the surveys.

SAMPLE DRS SUMMARY SHEET

	(1)	(2)	(3)	(4)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
Comments	Survey Date	Day of Week	Vehicle Number	Driver Number	Total Passengers	Total Vehicle Trips	Total Trip Distance	Passenger Miles	Total Trip Time	Passenger Minutes	Capacity Miles	Seat Miles
	010478	WED	54	15	36	7	21.2	108.1	105	519	568.8	3604
	"	"	"	22	xx	x	xx.x	xxx.x	xxx	xxx	xxx.x	xxxx
Heavy Snow	011278	ThR	10	14	xx	X	xx.x	xxx.x	xxx	xxx	xxx.x	xxxx
Forwarded to Page 2												

Form UMTA 2710.7 (12 77)

(Source: UMTA Procedures, Reference 63)

(vi) Annual Report. For those systems using federal operating monies, the asterisked items in the facing exhibit are essential to calculating the three required estimates:

1. Annual passengers: Obtain directly from Weekly Count Sheet.

2. Annual passenger-miles: Divide total passenger-miles (line 4) by total passengers (line 1) to get average trip distance (line 9); multiply average trip distance by annual total passengers (line 11) to get total passenger-miles (line 12).

3. Average passenger trip time: Obtain by dividing total passenger minutes (line 6) by total passengers (line 1).

Items not asterisked are byproducts of the sampling process and can be used by UMTA and the operating manager for analytical and evaluation purposes.

Additional account records, reporting descriptions, instructions and forms can be obtained from UMTA's Office of Transit Management.

7.3.2
Directory of Federal
Transportation Agencies

Appendix D
Page 2 of 2

PROVISIONAL FORM

UMTA C 2710.2
2-22-78

ANNUAL REPORT TO UMTA

	Line No.	Item	Total, All Samples
		Accumulations from DRS Summary Sheet	
*	1	(18) Total passengers in samples	______
	2	(19) Total trips	______
	3	(20) Total trip distance	______
*	4	(21) Total passenger miles	______
	5	(22) Total vehicle trip time	______
*	6	(23) Total passenger minutes	______
	7	(24) Total capacity miles	______
	8	(25) Total seat miles	______
		Sample Estimates	
*	9	Average passenger trip distance (4/1)	______
*	10	Average passenger trip time (6/1)	______
		Annual Totals	
*	11	Total passengers (From weekly count sheet)	______
*	12	Total passenger miles (11 X 9)	______

* Required by the Section 15 Reporting System

(Source: UMTA Procedures for Obtaining Data, Reference 63)

4.2.8 Collect Base-Line Data

During the implementation phase, base-line data will be collected to provide a basis for comparison with data collected during the operation and evaluation phases. Data collection for monitoring purposes must be closely coordinated with evaluation data collection activities. If a paratransit system is to be installed in an area with no previous transit history, the bulk of the base-line data will consist of descriptions of the service area and its population. Where a history of transit service exists, data should be collected to document levels of ridership on competing and complementary services, including taxi patronage.

Data collection during the implementation phase needs to be carefully scheduled

- To coincide with regularly-scheduled measurement activities;
- To avoid interference from competing innovations; and
- To minimize the possibility of misintepretation due to seasonal or local phenomena.

It is important that representatives of management and the evaluation team monitor the collection process to ensure that the data collected in the field provides an adequate statistical representation of the phenomena being observed. This monitoring process minimizes the chance of a misunderstanding between office personnel and field data collectors, and is a desirable precaution in all data collection activities. It is particularly necessary in obtaining base-line data, since this often represents the first interaction between evaluators and the field data collectors. Also the statistics being collected are highly perishable, in that they cannot be recaptured once the new system is installed.

4.2.9 Pre-Testing the System

It is important that every aspect of system operations be pre-tested prior to the initiation of system operations. Test procedures may range from simple pencil and paper simulations to elaborate dress rehearsals in which buses, drivers, dispatchers, and telephone operators respond to requests for service from a sample population of users. The sketch at the right illustrates a hierarchy of tests addressing both system operations and customer service. The tests in this hierarchy may be undertaken individually or combined to examine different aspects of a proposed system. The nature of the individual tests is outlined below.

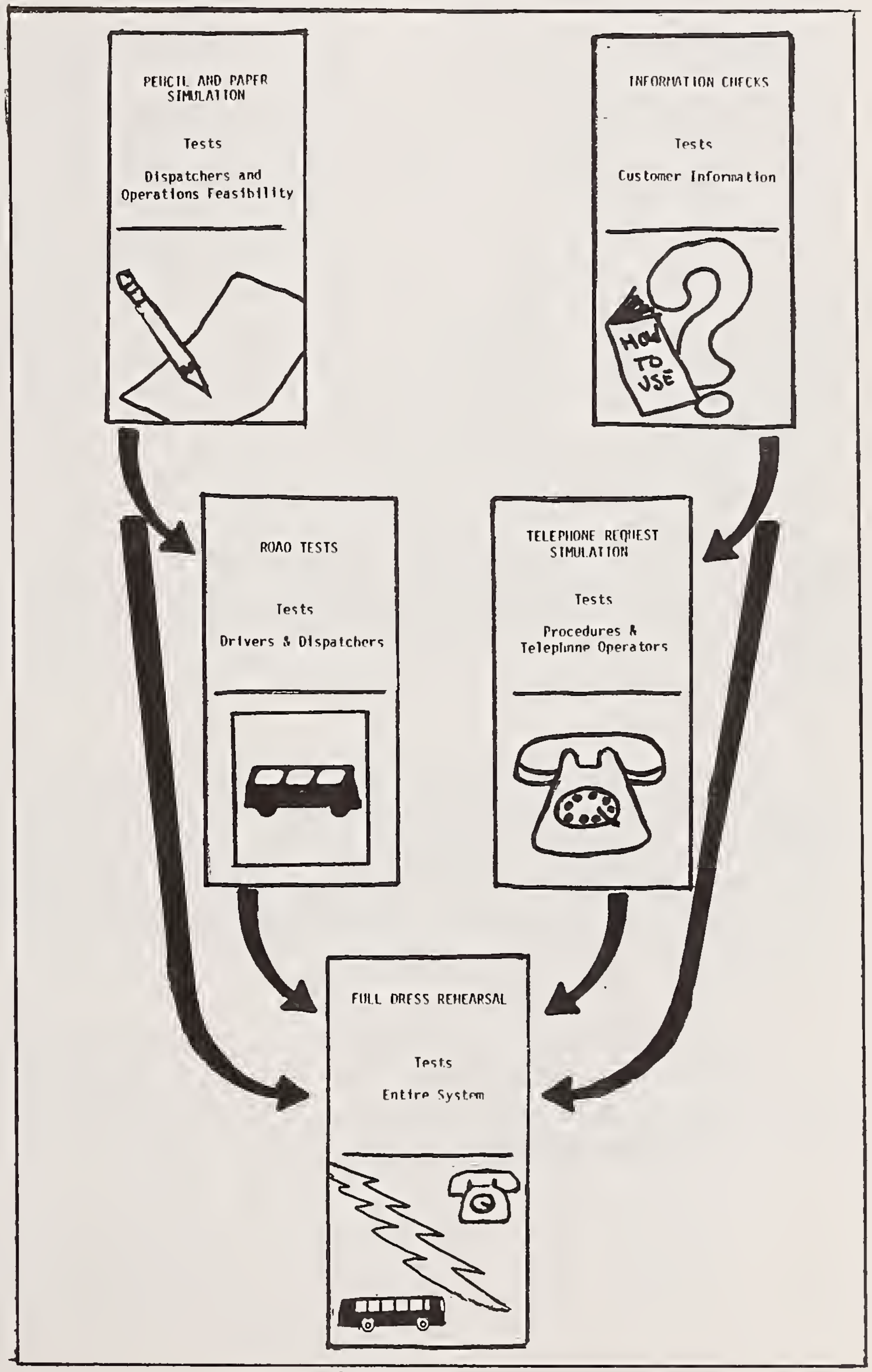
(A) Pencil-and-Paper Simulations

In this simple approach, design personnel generate sample trip origins and destinations, which are then assigned to vehicle tours by dispatchers. Tours are traced on a map of the service area. Average speeds and delays are used to account for time-in-transit of the simulated passengers. Typical averages for a general market dial-a-ride system might be:

- Running time = 4.5 minutes per mile
- Boarding time = 50 seconds per passenger (longer for most target-market systems)
- Drop-off time = 20 seconds per passenger (longer for most target-market systems)

Sample trips may be generated either by dropping into a hat chosen addresses from a telephone directory and

PRE-TESTING THE SYSTEM HIERARCHY



drawing successive origins and destinations, or by using a random number generator to identify longitudinal and latitudinal coordinates on an indexed map. The use of potential addresses adds "real" system exposure for the dispatcher will have to locate the address before scheduling pick-up times. In many-to-one systems, the simulator need only generate the trip origin, while in many-to-few systems, origins and destinations should be chosen in separate drawings. It may be desirable to choose origins and destinations separately even in many-to-many systems, so that common trip attractors (e.g., shopping centers or medical clinics) can be accorded a proportionately higher chance of occurrences as a trip-end.

The pencil-and-paper simulation helps to train dispatchers and gives the designer a better feel for tour times and trip patterns. As such, it is a useful exercise early in the design and implementation stages. However, it leaves several key elements of the system -- notably driver behavior and customer communications -- untested.

(B) Road Tests

The elements of the pencil-and-paper simulation may be expanded to test field operations by having the dispatcher direct buses and drivers in response to the randomly-generated trips. Drivers would proceed to the stipulated address, wait a prescribed amount of time for an imaginary "pick-up," and then proceed with the remainder of the dispatcher's tour.

This exercise serves both to train drivers and give planners and dispatchers better insights into the actual travel time experienced between different points at different times of day.

If the system is pre-tested and buses are dispatched without actually serving customers, it is important that the public be informed that such tests are being conducted. Otherwise, the presence of many empty buses on the road may generate ill-will and a sense of failure before the project begins. In Santa Clara County, several complaints of "wasted tax money" were received following a series of preliminary test runs using empty buses. Buses used in such tests should carry signs explaining their function and advertising the forthcoming system.

(C) Information Checks

Information materials advertising the system and instructing potential patrons in its use should also be tested in advance of the start-up date. This can be accomplished by assembling a group of volunteers having no previous experience with paratransit service, exposing this group to drafts of the user information materials, answering any questions that emerge from a first reading of the materials, and then instructing the members of the group to phone in requests for service on trips of their own devising. Since this exercise will also help to train telephone operators, all calls made by the volunteer group should be monitored by appropriate system personnel, both to gauge the adequacy of the information materials and to check the performance of the telephone personnel.

At the close of the exercise, the volunteers might be asked to comment both on the adequacy of the information materials and the relative attractiveness of the paratransit service being proposed. Short questionnaires should be prepared addressing these issues.

(D) Telephone Request Simulation

A more rigorous test of the system phone lines and telephone operators can be carried out in conjunction with the information-testing exercise suggested above. If the phone calls made by the sample population are augmented with calls from experienced members of a control group, the rate of incoming calls can be varied to simulate the load expected at different times of day. The performance of telephone operators under peak load conditions can be tested, and the mixture of calls from seasoned users and novices will make the process more true to life.

If the test shows that telephone operators are taking much longer than expected to respond to requests, the impact of this additional time may change some of the parameters set in planning and design phases. To compensate for long phone-response times it may be necessary to expand the number of phone lines, increase the number of operators, or shrink the size of the initial service area until operators and customers become more proficient in using the communications system. In Santa Clara County, the time required to complete a call was grossly underestimated at 30 seconds in the planning and design stages, with the result that most callers got busy signals or were placed on hold for as long as 45 minutes. This unhappy situation contributed significantly to the early demise of the service (Reference 86).

(E) Full Dress Rehearsal

The most exhaustive test of a fledgling paratransit system, short of the first day of operations, is a dress rehearsal in which sample user groups actually test the full scope of the system services. This dress rehearsal combines aspects of the road test with the simulated telephone requests described above. In this case, drivers respond to the requests made by members of the volunteer and control groups, and buses carry the tripmakers to their desired origins and destinations.

In target market systems, which often require advance registration, a break-in period might be established during which the system is used by a small number of accredited users. This number may be gradually expanded as more and more operating experience is obtained during the test period, until the system is made available to the full range of qualified users on opening day.

A general market system might be similarly tested by providing service to a limited number of zones in the service area during a break-in period. If this is done, the intent to expand the service throughout the area and the date of opening day should be publicized during the break-in period.

Any of the tests described in this section may be incorporated in the personnel training program for drivers, dispatchers, and telephone operators. More information on the training process may be found in Section 4.2.5 and Reference 43.

4.2.5
Staff Training

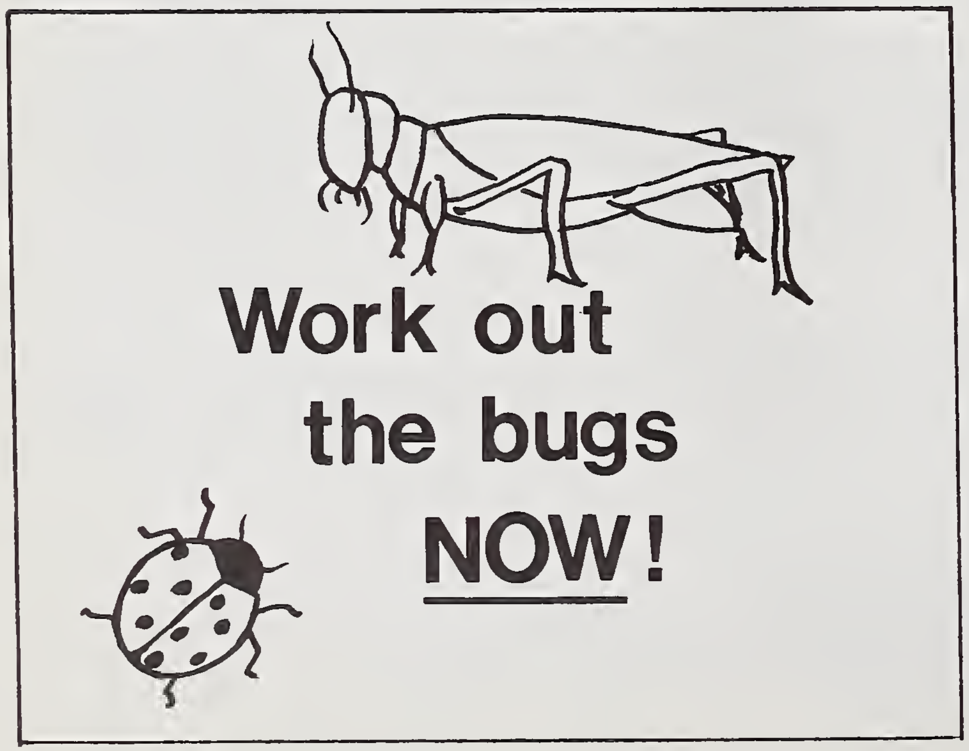
4.2.9

FINAL CHECK-OUT

Take time to make an objective assessment of the system status before the start of operations so that the transition will be as smooth as possible.

- System funding should be firm;
- Staff and equipment should be ready for work; and
- Regulatory and labor issues should be settled.

In your review of "ready or not" status, anticipate the next steps to be taken in operations. Make sure the system is prepared to begin operations; it can be disastrous for the system and the community to try to iron out difficulties or "catch up" with administrative loose ends once the operations begin.



4.3 Implementation Pitfalls

This section summarizes the major pitfalls to be avoided in implementing paratransit systems, as observed by system operators and evaluators.

OVERLY-RAPID INTRODUCTION OF THE SYSTEM

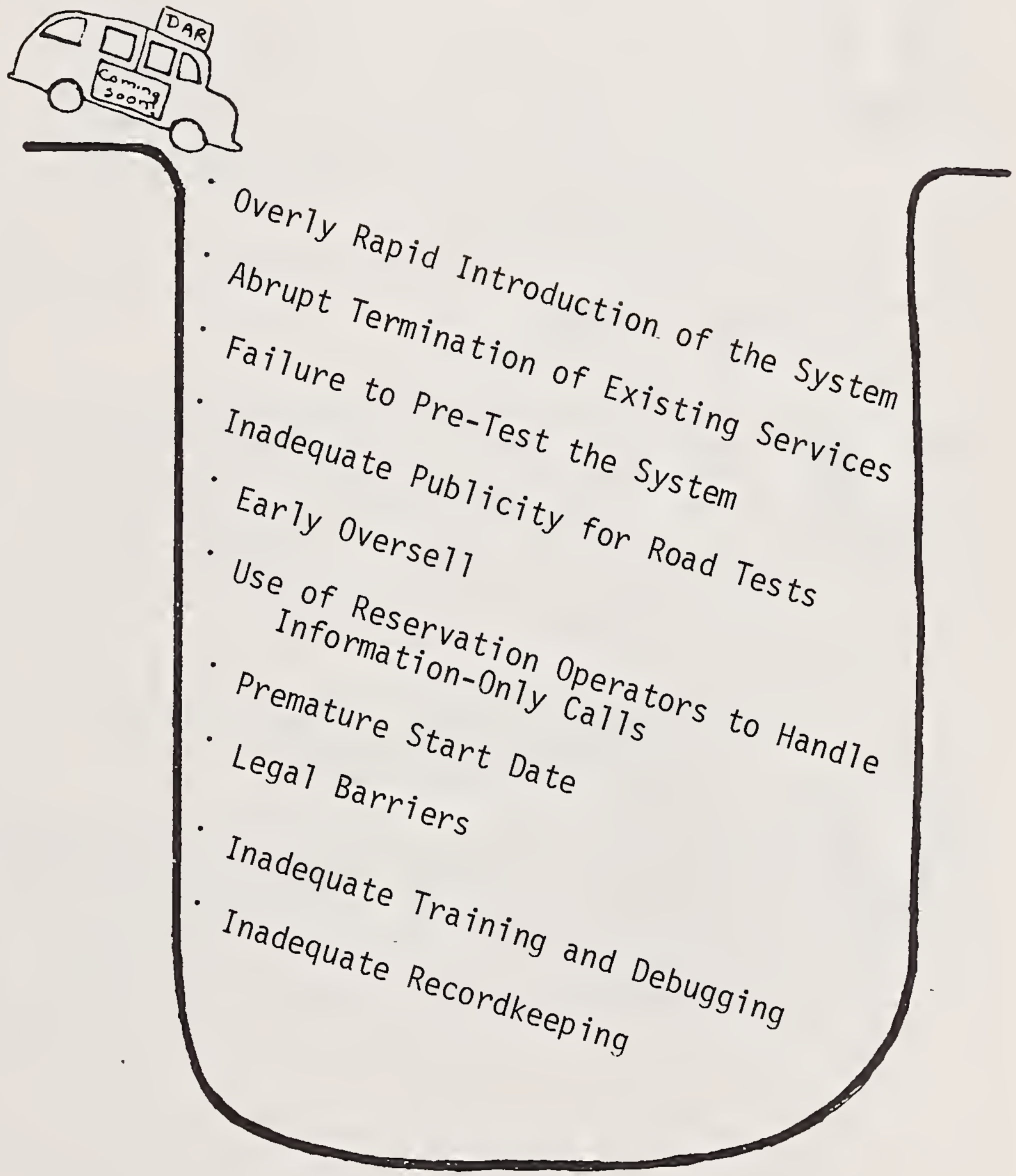
Proceed slowly and cautiously. It is better to expand the service area if the system is undersubscribed than to be forced to cut back coverage or fail to adequately serve initial demand.

ABRUPT TERMINATION OF EXISTING SERVICE

Where possible, allow for a transition period during which existing service and new paratransit service operate in tandem. (Wing-walkers' rule: "Never leave hold of what you've got until you've got hold of something else," as quoted in the Wall Street Journal, September 8, 1977.)

FAILURE TO PRE-TEST THE SYSTEM

Drivers, vehicles, telephone operators, and dispatchers all need a baptism of fire under realistic conditions. Information materials should also be pretested through exposure to prospective riders.



INADEQUATE PUBLICITY FOR ROAD TESTS

If the system is pre-tested by dispatching buses without actually serving customers, the public should be informed so that it doesn't appear that a "lot of buses are running empty." Perhaps the buses used in this capacity could bear signs explaining their function and advertising the forthcoming system.

EARLY OVERSELL

Excess demand during the early stages can swamp the system, turning off many potential riders who may never return. Marketing releases should be timed to avoid an early rush of demand before the system capabilities are tested and operations are proceeding smoothly.

USE OF RESERVATION OPERATORS TO HANDLE INFORMATION-ONLY CALLS

Just before and during start-up, a separate information telephone number should be made available to the public and manned by special operators who handle information-only calls.

PREMATURE START DATE

Uncontrollable delays may be experienced in the manufacture of equipment, and sufficient schedule slack should be planned for realistic delays. Public announcement of the start-of-service date should be made only after all essential equipment has been received.

LEGAL BARRIERS

If demand-responsive transit service is implemented in competition with other forms of transportation, legal barriers may develop and enabling legislation may be required. This legislation may be opposed by any transit organization that feels threatened by the new system. Allowances should be made for the resulting time delays, and purchase of major equipment should be scheduled to occur only after legal issues have been resolved.

INADEQUATE TRAINING AND DEBUGGING

U

Drivers and controllers require at least two weeks of basic training in procedures, public relations, equipment usage, and area familiarization. However, drivers usually take two to four months to thoroughly learn the street system, while controllers require about six months to become thoroughly proficient. Thus, for the first six months of operation, the system will be operating below capacity and should not be overstressed.

INADEQUATE RECORDKEEPING

U

After July 1978, no grants for UMTA Section 5 operating funds will be awarded unless the applicant has installed the Section 15 Uniform System of Accounts and Records.

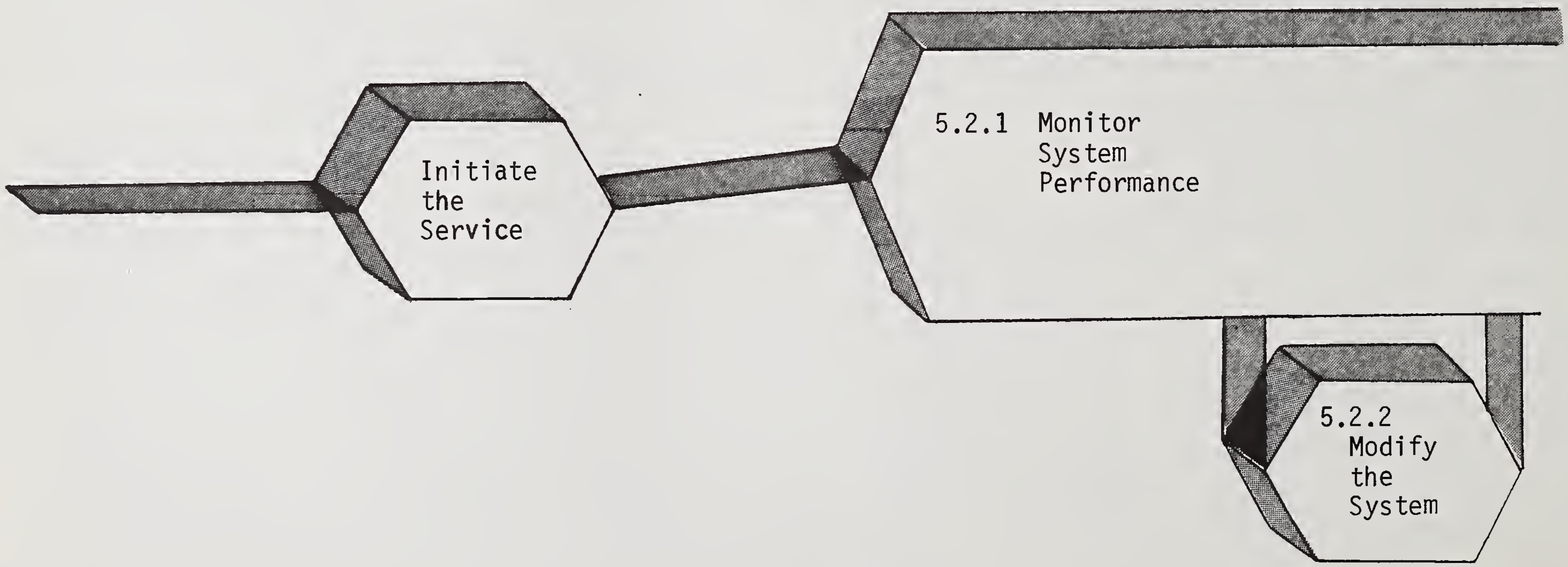
5.0 OPERATIONS

5.1 Overview

The operations phase begins with the initiation of revenue service and continues as the service is monitored and modified before reaching a steady state. It is useful to consider the operations phase as consisting of at least two stages: (1) start-up, in which ridership builds and the system is modified and debugged, and (2) steady-state, in which relatively few changes are made and ridership levels exhibit consistent trends.

5.1.1 Functional Tasks

Because of the flexibility of paratransit service, it is difficult to define specific tasks as a focus for discussion of the operations phase. The phase may be viewed as a continuing process of monitoring and system modification, and this structure has been used as a framework for discussing operational procedures. As indicated below, Section 5.2.1 discusses the monitoring function and management uses of data gathered during system operations. The subsequent section, Section 5.2.2, addresses major possibilities for system modification, identifies existing systems having experience with each possibility, and lists such general guidance as has emerged from this experience.

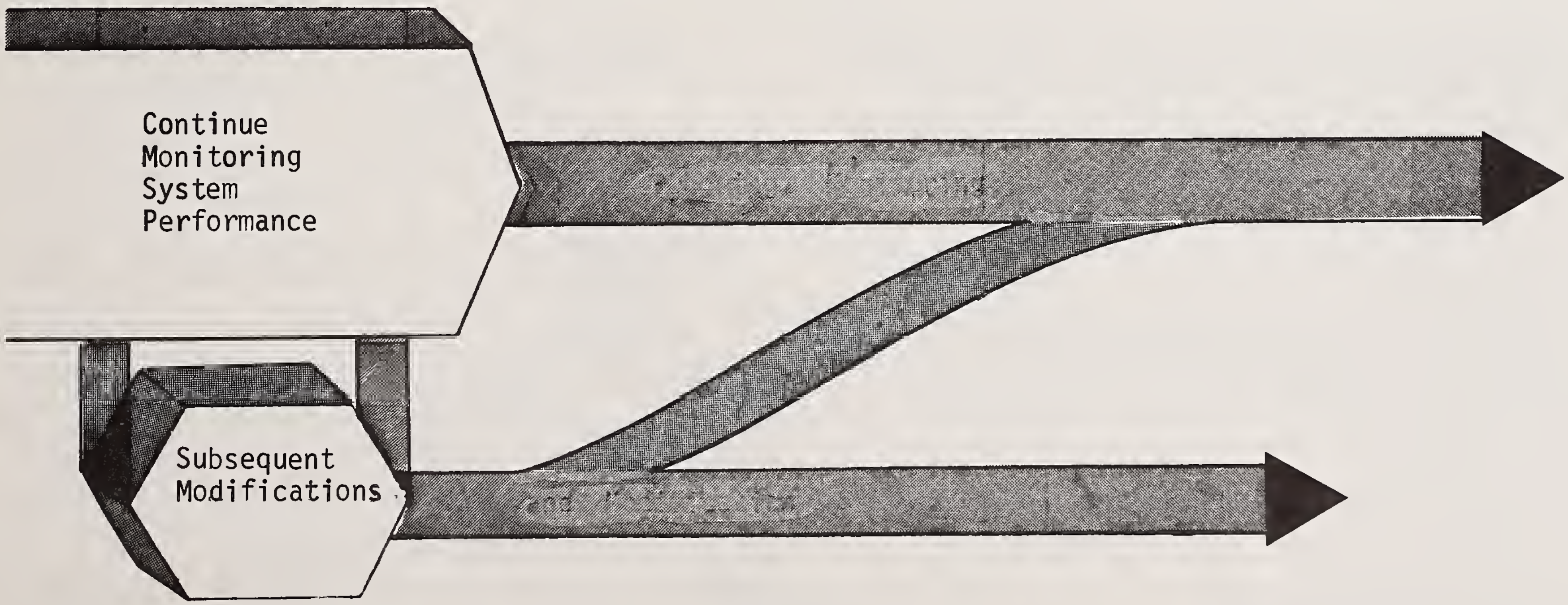


5.1.2 Timing

(A) Duration of the Start-Up Period

Even without allowing for the vagaries of user responses and ridership build-up, the start-up period can be expected to last a minimum of six months before any sort of steady stage is achieved. Drivers generally require at least four months to become thoroughly familiar with the street network, while controllers need about six months to become proficient in their dispatching tasks. Thus, at least six months will be needed before any new paratransit system will approach peak operating efficiency, and changes in ridership levels can be expected to extend this period still further. This learning period is just another in a long list of arguments for starting slowly.

With the majority of demand-responsive systems still weathering the first years of operation, there are relatively few sources for long-term operating information. Of the few systems supplying data, some reported that a year and one-half was needed to initiate service, build ridership, and monitor and modify the system before they approached a "steady state" operation. Orange County Transit District in Southern California began to evaluate and subsequently modify its DRT services after eight months of operation, and obtained a stable operating system within the following two months. Integrated fixed-route and paratransit services should expect a longer period before the system stabilizes.



5.1.2

(B) Failure Histories

Although little data is available to indicate the time required for paratransit system performance to stabilize in a steady state, there is some data to indicate the time before a system will shut down, if it is destined to fail. Of the 129 systems for which system profiles were assembled (see appendix), 17, or 13%, had been discontinued prior to the publication of this handbook. The illustration at the right traces the life-spans of these 17 systems. Over half of the failed systems shut down within one year of start-up, and over one-third lasted less than six months. It is unlikely that any of these systems were in existence long enough for either ridership or service to stabilize.

A variety of factors contributed to the failure of the systems identified in the accompanying exhibit. Most of the systems attributed their failure to excessive costs, but the list of other contributing factors cited represented a fair sampling of the pitfalls cited in this and earlier sections of the handbook.

The majority of the failed U.S. systems that survived for more than one year before closing their doors were federally-sponsored demonstration projects. When the demonstration had run its course and this outside source of funding dried up, so did the service.

5.1.3 General Operating Guidelines

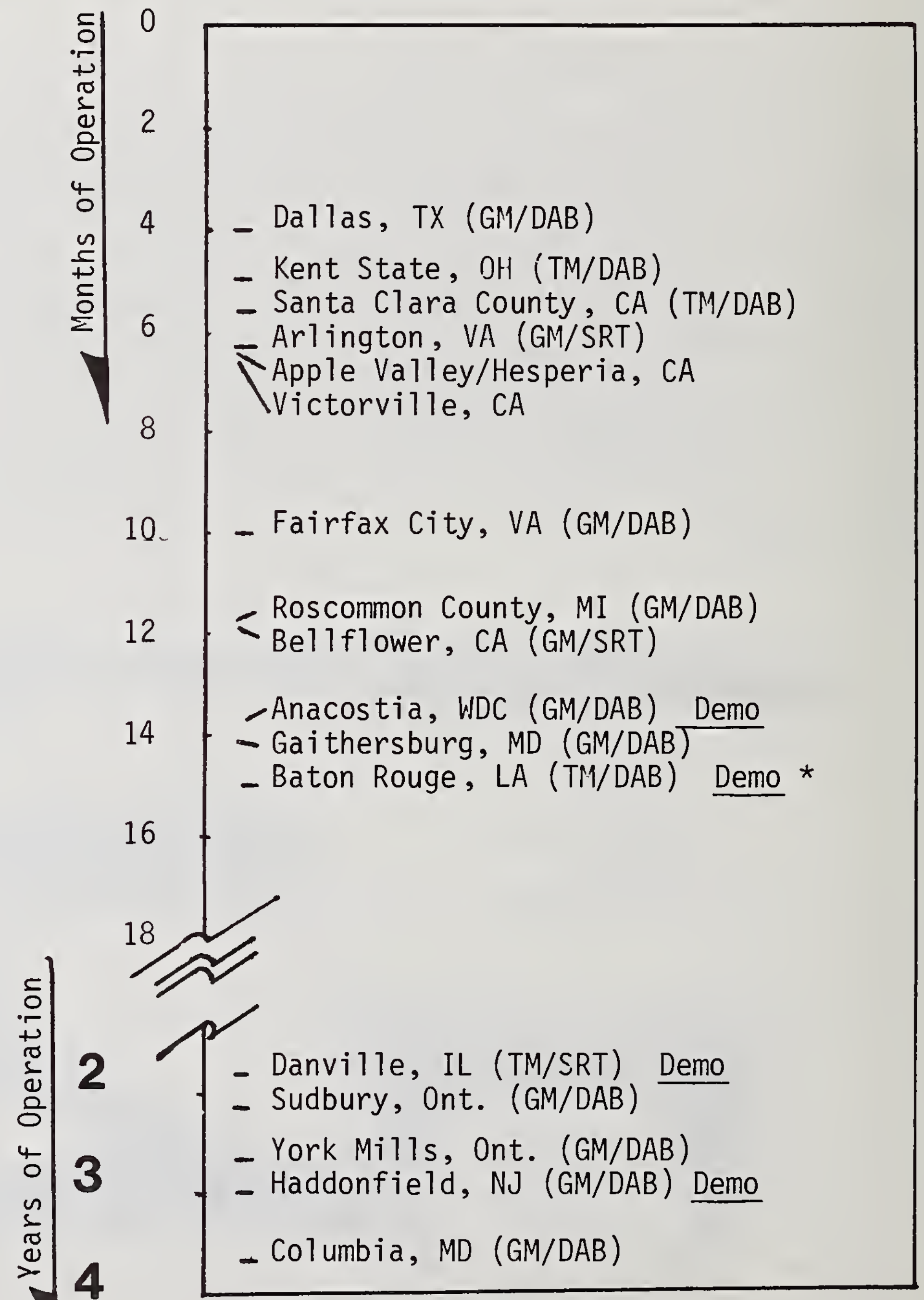
(A) System Modifications

Certain general principles should be followed in modifying paratransit systems:

- Proceed slowly;
- Keep changes small and evolutionary;

Go to
APPENDIX A-4
System Summary Sheets

TIME TO CLOSING
FOR 17 DISCONTINUED SYSTEMS



*Service renewed 1/76 under HEW Title XX Grant.

(Source: SYSTAN)

- Plan carefully, supplementing the initial planning and design procedures with information obtained from actual operations;
- Avoid too-frequent changes; and
- Publicize all changes widely.

Observations regarding specific system modifications may be found in Section 5.2.2.

(B) Improving System Productivity

The following general guidance for improving system productivity is offered by the Canadian Dial-A-Bus Manual (Reference 4):

- Encourage users to be ready for boarding upon the arrival of the vehicle.
- Use combinations of fixed-route and demand-responsive services during rush periods.
- Vary zone sizes to approach optimum tour lengths.
- Pre-arrange subscriber pick-ups in the most efficient manner.
- Put off demand calls to the next vehicle tour so as not to change critical tour patterns during rush periods.
- Use smaller and more maneuverable vehicles to increase overall speed and reduce mileage.
- Promote reverse commuting and off-peak usage.
- Introduce group demand pick-ups with existing subscriber addresses.
- Provide flag-stop (hail) service during the rush period.

O 5.2.2
Modifying the System

5.2 Procedures

5.2.1 Monitor System Performance

Maintaining performance records is essential not only to budgeting, but also as a means of assessing the overall efficiency of system performance. Records of passengers carried, revenues, driver hours, vehicle mileage, fuel consumption, trip times, and so forth can be combined to produce general indicators of effectiveness (cost per passenger, passengers per vehicle-hour, cost per mile) for comparison with other systems or with pre-set standards.

(A) Measures of Effectiveness and Efficiency

There are numerous measures of effectiveness and efficiency which may be used as yardsticks of system performance, as shown in the facing exhibit. The effectiveness indicators address the performance of the system relative to such operating characteristics as passenger service and energy efficiency. (Such measures include revenue passengers per vehicle-hour, operating cost per passenger, and energy consumed per passenger-mile.) Efficiency indicators address the use of resources in providing transit service. These measures largely ignore the impact of ridership in order to concentrate on such indices as operating cost per vehicle-hour, platform hours per pay-hour, and the percent of total vehicles scheduled for peak-period service.

Procedures for collecting the information comprising measures of both effectiveness and efficiency are discussed in Implementation, Section 4.2.8, and the Evaluation, Section 6.2; System Characteristics, Section 2, discusses the most significant measures and summarizes typical values for the range of operating systems.

(B) Management Uses of Performance Data

The tasks of assembling, constructing and reviewing the performance indicators constitute the primary flow of management information in a transit operation. This information flow must be capable of supporting:

(i) Assessments of whether the operation is running as planned;

(ii) Evaluations of the performance of such system sub-elements as individual routes, zones, and control procedures;

(iii) Documentation of the productivity of vehicles and labor; and

(iv) Analyses of promising changes in service policies, service patterns, and service levels, fleet management, and system control.

(C) Data Comparisons

A month-to-month comparison of performance indicators is needed to monitor trends in system effectiveness and efficiency as they develop. In most instances, however, management will want to compare their own system's performance with one or more external benchmarks. These benchmarks may be derived from pre-set objectives, past work measurement, industry averages, or equipment specifications, as outlined on the following page.

4.2.8 Base-Line Data

6.2 Evaluation Plan

2.0 System Measurement

EFFECTIVENESS AND EFFICIENCY INDICATORS

EFFECTIVENESS INDICATORS

Service Utilization

Annual passenger-trips/ population within 1/2 mile of route

Passengers/revenue vehicle-hour

Passengers/revenue vehicle-mile

Passengers/capacity mile

Passenger-miles/revenue vehicle-mile

Passenger-miles/seat-mile

Service Quality

% of trips on time

*Average demand-responsive wait time

Wait time variance

Actual revenue vehicle-miles as a % of schedule revenue vehicle-miles

Average % of total vehicles available for service

Average fixed-route headway (peak and off-peak)

Number of breakdowns in service/1,000 vehicle-hours

Safety

Number of accidents/ 1,000 vehicle-hours

Cost Effectiveness

Total operating cost/ revenue passenger-trip

*Total operating cost/ total passenger-trips

Total operating cost/ passenger-mile

Net operating cost/ revenue passenger-trip

Fare revenue/passenger-trip

Externally-provided funding/passenger

Externally-provided funding as a % of operating cost

Fare revenue as a % of operating cost

Non-farebox local revenue as a % of operating cost

Accessibility and Service Supplied

% of population within 1/2 mile of route

% of transit dependents within 1/2 mile of route

Vehicle revenue-miles/ square mile of service area

Unit of service provided/ capita

Unit of service provided/ capita within 1/2 mile of route

Economic, Environmental and Energy

Total energy consumed/ unit of service

Distribution of retail sales

Gasoline consumption

Automobile miles of travel

Passenger-miles/unit of fuel consumed

* Represents measures for which representative data appears in System Characteristics (Part III).

EFFICIENCY INDICATORS

Cost Efficiency

*Total operating cost/ revenue vehicle-hours

Total operating cost/ revenue vehicle-mile

Transportation operations cost/unit of service

Revenue vehicle maintenance costs/unit of service

General maintenance cost/ unit of service

Administration cost/ unit of service

General administration cost as a % of operating cost

% annual change in vehicle operator's wage rate

% annual change in labor wage rate

% annual change in average operator's cost

% annual change in average labor cost

Labor Utilization

Revenue vehicle-hours/ employee

Total platform hours/ pay-hours

Revenue vehicle-miles/ employee

Passenger-trips/employee

Vehicle Utilization

Revenue miles/vehicle

Revenue hours/vehicle

% of total vehicles scheduled for peak-period service

Passengers/vehicle

(Source: SYSTAN)

(i) Pre-Set Objectives. Typically, pre-set standards will be related to system goals and objectives. An example of the standards established for the Portland LIFT System appears at the right.

Often, however, pre-set standards are arbitrary and bear little relationship to actual operations; managers are praised for achieving goals they couldn't possibly miss, and criticized for falling short of goals they couldn't possibly achieve. If quantitative standards are developed in advance of system implementation, these standards should be as realistic as possible.

(ii) Ongoing Measurement. This approach to standard-setting compares future performance to past performance, and expresses goals in terms of improvement percentages (i.e., a 5% increase in ridership per month). This approach must also be related to reality through comparisons to other systems. If not, management may be requiring impossible increases or settling for unnecessarily low performance levels.

(iii) Industrywide Averages. The System Characteristics section of this handbook assembles industrywide statistics for different paratransit services. Individual system statistics are included in Appendix 4. In general, it is better to compare a specific system with a carefully-constructed average measure than to attempt to make direct comparisons between individual systems. In any single system, one or more performance measures may be significantly influenced by political, geographic, or demographic factors which are outside the control of the transit managers. The use of one system as a standard for comparison is likely to be invalidated by the idiosyncrasies of either the standard system or the monitored system, unless the systems are carefully matched to hold the extraneous factors constant (Reference 39). A comparison of one system with the average of a like group of systems presents fewer problems, as the averaging process tends to even out fluctuations, thereby producing a less ambiguous baseline for purposes of comparison.

SAMPLE GOAL-RELATED STANDARDS

(Portland LIFT System for the Handicapped, Reference 1002)

1. Cost per ride of $3.00.
2. 40% revenue-to-cost ratio.
3. Social service agency contracts of $500,000 or more.
4. At least 850 one-way rides/day within 6 months.
5. Fewer complaints per passenger-mile than those received for existing fixed-route service.
6. No missed pick-ups after 60 operating days.
7. Computerized billing costs not to exceed corresponding manual costs.
8. Improved mobility for LIFT users.
9. Inclusion of elderly and handicapped representatives in advisory committee and program.
10. Integration, not elimination, of cab service with LIFT service.
11. 80% of all pick-ups in the first six months should be within 15 minutes of promised pick-up time.

(Source: The Lift, Reference 77)

Industrywide Statistics

Go to Appendix A-4 Individual System Statistics

(iv) Equipment Specifications. Fuel consumption is an example of an efficiency measure that can be compared both with industrywide averages and with individual equipment specifications. If the measured consumption rate seems excessive, investigation is required to determine the causes (i.e., pilferage, excessive idling, poor maintenance).

(D) Additional Comments

- Management personnel should observe both system operations and the data collection first-hand before attempting to interpret statistical comparisons or undertake system modifications.

- System changes may be triggered by qualitative observations (such as complaints about impolite drivers) as well as by quantitative comparisons.

- Rules of thumb need to be developed to alert management to problem areas and trigger system changes. Guidance in this area is currently lacking, and it is hoped that general principles will be developed and presented in future editions of the handbook. Management also needs to have more general standards identifying the signs of a viable system, such as desirable rates of growth, historical evolution of service levels, typical ridership trends, and acceptable deficit levels.

5.2.2 Modifying the System

One of the key selling points of paratransit systems is their flexibility. As operating experience is gained, pressures will be exerted to test this flexibility. If a system is perceived as successful, pressures will be exerted by unserved areas wanting system expansion, by operators attempting to improve productivity, and by policymakers attempting to increase system benefits. An unsuccessful system, on the other hand, may undergo even more pressure for change to "make it work." This pressure is likely to come from the same sources: the public, operators and policymakers. Certain general principles should be followed in modifying paratransit systems:

- Proceed slowly;
- Plan carefully, supplementing the initial planning and design procedures with information obtained from actual operations; and
- Publicize all changes widely.

The flexible nature of paratransit systems allows a wide variety of system modifications, the most important of which are listed at the right. Although many existing systems have undergone one or more of these modifications, relatively little documentation exists to support detailed impact analyses or to provide explicit guidance for other systems contemplating such changes. This section addresses the major possibilities for system modification, identifies those systems having experience with each possibility, and lists such general guidance as has emerged from this operating experience. Operators contemplating one or more of the listed modifications may wish to contact the listed systems themselves for guidance.

TYPES OF SYSTEM MODIFICATIONS

- CHANGING GEOGRAPHIC COVERAGE
  - Expanding service area
  - Decreasing service area
- CHANGING SERVICE TYPE
  - Replacing fixed-route service with paratransit
  - Replacing paratransit with fixed-route service
  - Introducing different peak and off-peak policies
  - Adding or subtracting special services
- CHANGING ELIGIBILITY REQUIREMENTS
  - Restricting eligibility
  - Relaxing ridership restrictions
- CHANGING FARE STRUCTURES
- CHANGING SERVICE LEVELS
  - Changing vehicle operations or services offered
  - Changing service hours
  - Modifying intersystem transfer times
- CHANGING THE CONTROL SYSTEM
  - Adjusting the level of automation
  - Changing dispatching policies

(Source: SYSTAN)

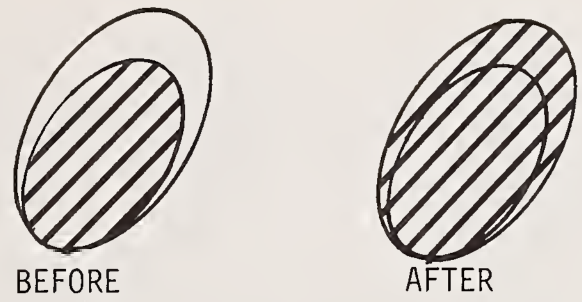
(A) Changing Geographic Coverage

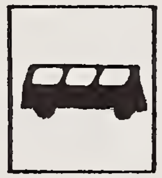
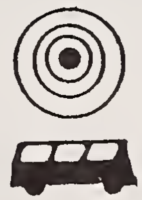
<u>(i) Expanding Geographic Coverage</u>. An expansion of service area has been the most common modification undertaken by existing systems. Systems reporting expanded service areas are indicated at the right. It is not surprising that service area expansion should be a common experience among paratransit systems, as this measure represents a response to both underutilization and overutilization of a system. If a system is not attracting enough riders, an expansion promises to build ridership levels for little additional investment. This is particularly true if neither buses nor dispatching facilities are being used to capacity, since such important system parameters as operating speed and dispatching system design will not need to be altered (Reference 4).

If a system is attracting a large ridership, there will still be pressure to widen its area of operations. In some systems, incremental expansion has been a part of the initial implementation plan.

Service-area expansions must be carefully planned, even if it appears that the existing system has ample capacity. Attempts to serve too wide an area can lead to systemwide deteriorations in service. In Haddonfield, NJ, the introduction of two service area expansions without an accompanying increase in vehicle supply brought about significant increases in wait and ride times, resulting in the loss of much of the initial ridership gained by the expansion (Reference 37).

When expansion into newly-developed areas is contemplated, studies will be required to determine the type of service to offer and the extent to which dispatching facilities will need to be upgraded. Planners and designers



SYSTEMS EXPANDING SERVICE AREAS		
Apple Valley, CA	# 1	
Dallas, TX	# 49	
La Habra, CA	# 7	
Houghton Co., MI	# 34	
Rochester, NY	# 81	
Haddonfield, NJ	# 46	
Kingston, Ont.	--	
Bay Ridges, Ont.	#123	
Ann Arbor, MI	# 80	
Tucson, AZ	# 82	
Cuyahoga Co., OH	#121	
St. Petersburg, FL	# 91	
West River, ND	#105	
Baton Rouge, LA	# 94	

(Source: SYSTAN Surveys)

should return to Section 3.2.3 to consider likely areas for expansion and to Sections 3.2.5 and 3.2.6 to gauge the impact of the potential system adjustment on demand and performance. At this stage, the demand and performance estimates will be improved by actual operating data from the existing service.

If surveys have been conducted on the popularity of the paratransit concept, those areas of the city that responded most favorably should be listed in order. System expansion should generally follow this order, as it is an indication of the probable acceptance of the new service.

The following general observations on system expansion have been culled from the Canadian Dial-A-Bus Manual (Reference 4):

- The availability of vehicles and communications equipment must be taken into consideration when planning service expansion.
- If DAB service is expanded too quickly or without adequate planning, it is possible that the system will be unable to meet heavy demand.
- Generally, higher patronage will benefit both a DAB system and an existing transit system, because the capacity of the dispatch center (which should be maximized) will normally increase faster than the incremental costs of providing the control systems.
- Since most existing transit systems have been experiencing declining patronage, there is usually some reserve capacity. Thus, increases

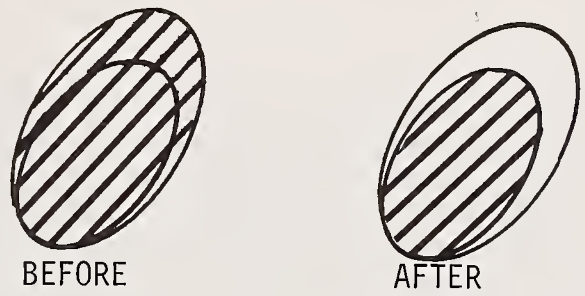
3.2.3 Service Boundaries
3.2.5 Demand and Fleet Estimation
3.2.6 Design Tradeoffs

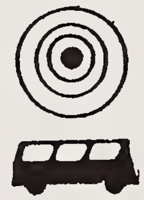
can often be made without any significant effect on overall fixed costs. The major area of concern is to have sufficient capacity to meet rush-hour demands.

(ii) Decreasing Geographic Coverage. In cases of both too much and too little ridership, the natural response is usually expansion of the service area; the possibility of decreasing service area size is rarely considered. Such a move is generally politically unpopular, and will usually be preceded by attempts to alter service policies or service levels. Reductions in service area size are usually considered only when a system is badly overextended, with a wide scattering of origins and destinations and generally poor service. Only two of the target market systems responding to the survey (Boston, Massachusetts and Syracuse, New York) reported reducing the size of their service areas. In both cases, moreover, the reduction was tempered somewhat by concessions to the area being deprived of service. In Syracuse, service was provided on a one-day-per-week basis to the areas deprived of service. In Boston, a fringe service area was eliminated at the same time the basic service area was expanded to include portions of the fringe area.

(B) Changing Service Type

Far too little practical experience exists to provide general rules for replacing one type of service with another. It is not even necessarily true that door-to-door paratransit service will be viewed by the public as preferable to fixed-route service. In Greece, New York, an attempt to replace an established fixed-route service with paratransit service failed when riders accustomed to fixed-route schedules found the relative uncertainty of doorstop paratransit service to be less desirable than tightly-scheduled arrivals and departures from corner stops.



SYSTEMS CONTRACTING SERVICE AREAS		
Syracuse, NY	#104	
Boston, MA	# 96	

(Source: SYSTAN Surveys)

5.2.2

If any generalization is possible on the basis of limited experience, it is that regular customers are likely to become attached to any existing service, and will view attempts to replace that service with skepticism. Accordingly, no change in service -- whether from fixed-route to paratransit or vice versa -- should be made precipitously. It might be wise to plan for a transition period during which new and old services coexist. If labor constraints make this impossible, different peak and off-peak operating policies might be initiated as a first step in the transition phase.

(i) Replacing Paratransit With Fixed-Route Service. In theory, as paratransit ridership increases, a point will be reached at which portions of a paratransit system should be converted to fixed-route service. In practice, a few U.S. systems attempting to replace paratransit service with fixed-route service have encountered resistance, and returned to paratransit service after experiencing a drop in ridership. In two Canadian systems (Bramalea and Cambridge, Ontario), paratransit service was successfully replaced with fixed-route service in response to high ridership levels, while in a third Canadian system (Winnipeg, Manitoba), a similar change was made because the high costs of paratransit service were unacceptable.

(ii) Replacing Fixed-Route Service With Paratransit. When supplanting fixed-route service with paratransit service, it should not be assumed that door-to-door service will be immediately perceived as superior to the existing service. The fixed-route service will have developed a hard core of riders and is likely to be more dependable during the peak-hour commute period. Again, a transition

SYSTEMS REPLACING PARATRANSIT WITH FIXED-ROUTE SERVICE	
*Orange, CA	# 63
*Claremont, CA	# 56
Bramalea, Ont.	--
Cambridge, Ont.	#125
Winnepeg, Man.	--

*Temporary replacement only; riders preferred paratransit

SYSTEMS AUGMENTING PARATRANSIT WITH FIXED-ROUTE SERVICE	
Rochester, NY	# 81
Westport, CT	# 79

(Source: SYSTAN Surveys)

period may be desirable during which both new and old services coexist.

(C) Changing Eligibility Requirements

Changing eligibility requirements is one means of adjusting ridership to meet system capabilities once a system is in operation. This approach is particularly effective in target market systems. If the system is so swamped with demands that service suffers, eligibility requirements may have to be made more rigid. If, on the other hand, excess capacity exists, the system may be made available to a wider portion of the public.

<u>(i) Tightening Ridership Requirements</u>. Means of introducing more rigid ridership requirements include:

- o Requiring subscription commitments during peak hours to ease peak loading problems
- o Restricting ridership to a more limited portion of the target market
  - Increasing eligibility age
  - Adding low-income requirement
- o Limiting the number of rides per month per subscriber

<u>(ii) Adding to Eligible Population</u>. Means of adding to the eligible population include:

- o Relaxing ridership restrictions
- o Supplementing subscription service with call-and-demand service and hail service

CITIES INTRODUCING MORE RIGID RIDERSHIP REQUIREMENTS	
Palo Alto, CA	#117
Dade Co., FL	#120
Lafayette, CA	#115
Huntington Park, CA	#114

SYSTEMS INCREASING POPULATION ELIGIBILITY	
Chicago, IL	# 92
Portland, OR	#108
Syracuse, NY	#104

(Source: SYSTAN Surveys)

- Adding equipment capable of serving the elderly and handicapped

(D) Changing Fare Structures

Information regarding the impact of fare changes on dial-a-ride systems is relatively scanty and difficult to interpret because of the many service changes and marketing programs accompanying the fare changes. Accordingly, the comparisons in this subsection should be considered to be descriptive, site-specific information rather than indications of general principles.

To provide a framework for considering the effects of fare changes on demand-responsive ridership, it is useful to consider the impact of fare changes in conventional transit systems. Available data indicate that, for most conventional transit systems in the United States in the mid-1970's, demand elasticity tended to be about -0.3 at a 25 cent fare, -0.6 at a 40-cent fare, and -1.0 at a 75-cent fare (Reference 54). These elasticities imply that demand is relatively insensitive to price changes at low fares, but that at fares approaching 75 cents, demand becomes sufficiently sensitive to price that a specified percentage increase in fares will cause a corresponding percentage reduction in ridership. Scattered data on conventional taxi systems imply that demand responses to price changes exhibit unit elasticities for average taxi fares of 95 cents (Reference 54). At higher levels, fare increases cause disproportionate rider drops, with consequent losses in total revenue. The facing exhibit plots the implied elasticities for conventional transit service, along with the dial-a-ride experience accumulated to date.

SYSTEMS DECREASING FARES	
Huntington Park, CA	#114
Haddonfield, NJ	# 46
Rochester, NY	# 81
Ann Arbor, MI	# 80

SYSTEMS INCREASING FARES	
Traverse City, MI	# 75
Claremont, CA	# 56
Arcadia, CA	# 52
Monrovia, CA	# 61
Columbus, OH	# 48
Haddonfield, NJ	# 46
Ann Arbor, MI	# 80
Huntington Park, CA	#114

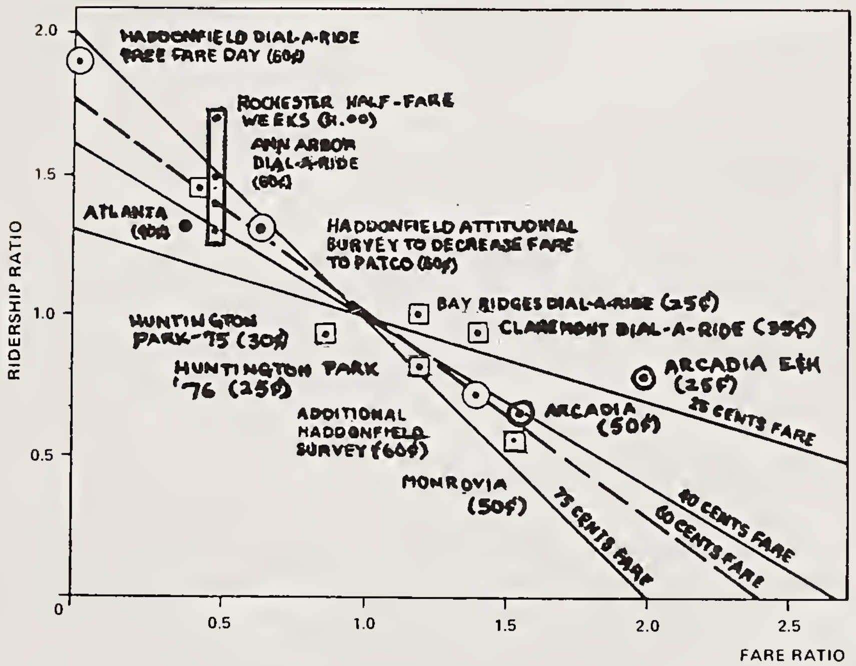
(Source: SYSTAN Surveys)

(i) Responses to Decreased Fares. In Haddonfield, New Jersey, fares were initially lowered and then raised just prior to the discontinuation of the system. Additional insights into fare elasticities resulted from a fare-free day and several surveys conducted during the project. The fare-free day nearly doubled Haddonfield ridership. In Rochester, several half-fare weeks (when fares were reduced from $1.00 to 50¢) increased ridership from 32% to 73%, with the largest increase occurring just after system initiation when many riders were one-time-only test riders. A special off-peak fare reduction (to 50¢ from $1.05) for riders transferring to fixed-route service resulted in an estimated 38% increase.

In the early operating history of the Ann Arbor, MI system, a fare decrease from 60¢ to 25¢ resulted in a 48% increase in ridership. Finally, in Huntington Park, a fare decrease from 30¢ to 25¢ was accompanied by a 4.2% decrease in ridership.

(ii) Responses to Increased Fares. As with fixed-route systems, limited experience has shown paratransit ridership to be relatively insensitive to incremental fare increases when the original fare is low. The systems in Bay Ridges and Claremont experienced relatively insignificant drops in ridership after the base fare levels of 25¢ and 35¢ were raised slightly. A more pronounced decrease of 28% was experienced in Huntington Park when the average fare increased from 25¢ to 30¢, but this was part of a general ridership decline which had failed to respond even to a previous decrease in fares. In Arcadia and Monrovia, California, fare increases from 50¢ to 75¢ resulted in patronage declines of 37% and 44%, respectively, among regular riders. The Monrovia decline was aided by a 33% cutback in service hours. In Arcadia, a doubling of elderly and handicapped fares from 25¢ to 50¢ resulted in a 22% decline in patronage.

EFFECT OF FARE CHANGE ON TRANSIT DEMAND



(Source: Mouchahoir, Reference 54, updated with SYSTAN survey information)

5.2.2

Although there is clearly not enough information to support general conclusions regarding elasticities for planning purposes, it appears that elasticities in demand-responsive systems are not unlike those of fixed-route systems. Demand is relatively inelastic (-0.3 or lower) at low fare levels in the 25¢ range. As the fare increases, demand becomes increasingly sensitive to fare changes, with elasticities of -0.7 being experienced around the 50¢ fare level and elasticities of 1.0 or greater characterizing fares of 75¢ or more. At higher fare levels, fare increases can be expected to cause disproportionate ridership drops, with consequent losses in total revenues.

Even less information exists regarding the sensitivity of elderly and handicapped patrons to fare changes. The single data point (Arcadia) suggests that members of these captive target markets are less sensitive than general market riders to fare changes at low fare levels.

(E) Changing Service Levels

The conventional wisdom of the traditional transit industry states that ridership is more responsive to service time improvements than to fare reductions. This is difficult to prove or disprove for paratransit systems. It does seem fair to observe, however, that more paratransit systems have failed because service was felt to be unreliable than because fares were set too high.

Few systems have consciously instituted distinct changes in service levels, and fewer still have amassed sufficient data on these changes to support a quantitative analysis of the intricate relationship of demand and service. In Rochester, New York, one of the best documented paratransit demonstrations, attempts to develop

SYSTEMS REPORTING SERVICE LEVEL CUTBACKS		
Batavia, NY	# 47	
Rochester, NY	# 81	
Dallas, TX	# 49	

SYSTEMS REPORTING FLEET ADDITIONS		
Gladwin, MI	# 30	
Niles, MI	# 73	
San Bernardino, CA	# 65	
Central Mass.	# 97	 
Topeka, KS	# 93	
Kent, OH	#106	
Baton Rouge, LA	# 94	

(Source: SYSTAN Surveys)

quantitative relationships between demand and service levels failed when it became apparent that such factors as vehicle breakdowns and changing service area size had a greater influence on demand than measured response reliability and travel time.

In the absence of definitive data on the relationship between service improvements and system ridership, this section will set forth descriptive material identifying the types of service level changes reported by existing systems and, when possible, the apparent results of these changes. Three major categories of changes will be discussed:

- Changes in vehicle operations or services offered;
- Changes in operating hours; and
- Changes in intersystem transfer times.

<u>(i) Changes in Vehicle Operations or Services Offered.</u> In two of the three systems in which service-level cutbacks were reported, the cutbacks were due to legal pressures. Batavia, New York eliminated schoolbus and charter service in response to changes in the federal law. The subsequent loss of ridership took the system from the black into the red. In Dallas, many-to-many operations were halted in response to claims of unfair competition from taxi operators. In Rochester, New York, the number of vehicles allotted to a newly-expanded service area was cut back when ridership in the area failed to come up to advance predictions. The service cutback was not accompanied by a drop in ridership, because the remaining buses were equal to the task of serving the lower ridership levels.

Few major fleet additions were reported by operating systems, although several general market and target market systems added one or two vehicles to their normal operations. Niles, Michigan added a wheelchair bus to its operation, while Gladwin, Michigan introduced a school route while adding a second and third bus to its citywide service. Of the target market systems, Topeka's LIFT system reported a ridership increase following the addition of a third bus, while Kent, Ohio increased ridership by expanding the capacity of its vehicles.

<u>(ii) Changes in Operating Hours.</u> A few systems have found it desirable to make minor adjustments in operating hours to accommodate specific travel groups. In Gaithersburg, Maryland, system operations were extended for one-half hour daily to meet the needs of a local employer. San Bernardino, California, expanded operating hours to include the midday period after approximately one year of service.

In Rochester, service was discontinued during the less productive evening hours between 3:30 p.m. and 10:30 p.m., with the resulting loss of ridership during that period. However, it appeared that ridership during the remaining service hours (8:00 a.m. to 3:30 p.m.) was not significantly affected by the cutback. In this case, a 48% cut in operating hours resulted in a 35% drop in patronage. In Monrovia, California, a 33% reduction in operating hours, accompanied by a 50% fare increase, resulted in a 44.5% decline in ridership.

<u>(iii) Modifying Intersystem Transfer Times.</u> Integrated system components should be designed to be mutually reinforcing and should be operated to ease the burden of any intersystem transfers which occur.

SYSTEMS INCREASING OPERATING HOURS		
Tracy, CA	#13	
Gaithersburg, MD	#17	
Calgary, Alberta	#122	
San Bernardino, CA	#65	

SYSTEMS DECREASING OPERATING HOURS		
Rochester, NY	#81	
Dallas, TX	#47	
Monrovia, CA	#61	

(Source: SYSTAN Surveys)

Ridership surveys indicate that transfers in general are a significant impediment to use, out of proportion to the time required to make the transfer. Therefore, it is important to make them as convenient and comfortable as possible.

After service is implemented, it may be necessary to revamp routes and schedules so that transfers are well-coordinated and service is geared to the pattern of the local activity system. As activity patterns change, transportation services should respond to changes to meet demand. Where large numbers of travelers are making the same transfer, operators should consider the possibility of providing non-transfer service.

The Westport Integrated Transit System offers an example of a system which has adjusted its service to provide better connections with commuter rail service.

(F) Other Operating Changes

In addition to the changes identified in the above sections, other modifications reported by operating systems include:

(i) Introduction of Computer-Assisted Scheduling

- Cuyahoga County, Ohio (121)
- Calgary, Alberta (122)
- Rochester, New York (81)

(ii) Change in System Operator

- Hemet, California (5)
- Rubidoux, California (12)

(iii) Merger With Other Systems

- Isabella County, Michigan (35)

(iv) Coordination of Social Service Transport Services

- Rhode Island (110)

These changes, like many others reported in this section, are too isolated and system-specific to provide a basis for generalized guidance. However, operators contemplating similar changes are advised to contact knowledgeable personnel in the identified systems to obtain the benefits of such experience as exists to date.

5.3 Operational Pitfalls

This section summarizes the major pitfalls to be avoided in operating paratransit systems, as reported by evaluators and operators of existing and failed systems.

RAPID, SWEEPING CHANGES

Avoid sweeping changes and rapid, large-scale expansion. Proceed slowly and cautiously.

ABRUPT SERVICE TRANSITIONS

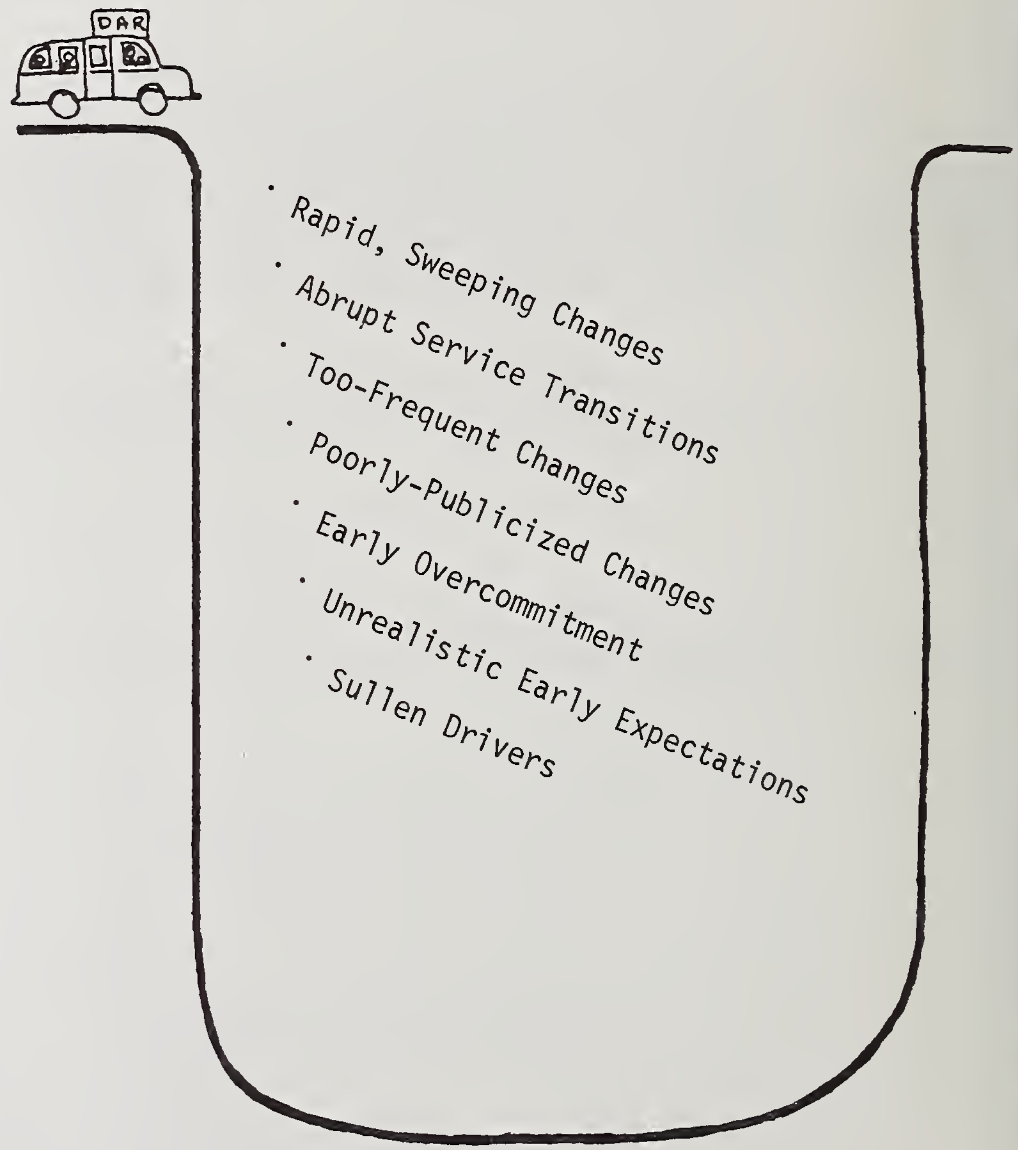
When replacing fixed-route service with flexible-route service, or vice versa, allow a transition period during which both services operate in tandem. (Recall the Wing-walkers' rule: "Never leave hold of what you've got until you've got hold of something else.")

TOO-FREQUENT CHANGES

Continual system meddling confuses the public and makes the monitoring and evaluation tasks much more difficult.

POORLY-PUBLICIZED CHANGES

All aspects of all service changes should be fully publicized. Several failed systems cited generally poor publicity as one cause of failure.



EARLY OVERCOMMITMENT

In one system, the full commitment of all available buses to service at the start of operations hindered the subsequent ability to expand efficiently once ridership patterns were known. The rate of growth was stunted by the inability to obtain new buses in a timely fashion. It seems advisable to hold some equipment in reserve, both to cover breakdowns and facilitate expansion.

UNREALISTIC EARLY EXPECTATIONS

For at least the first six months of operation, drivers, telephone operators and dispatchers will be learning their tasks, riders will be learning to use the system, and many mistakes will be made. Avoid overstressing the system during this early start-up period, and have confidence that things will improve. But monitor closely to make sure things do improve.

SULLEN DRIVERS

Paratransit operations require more of a driver than fixed-route systems in many ways. Because paratransit drivers have more interaction with passengers, it is even more essential that they be friendly, courteous, and helpful.

6.0

6.0 EVALUATION

6.1 Overview

In the context of these guidelines, evaluation connotes a broader concern than day-to-day monitoring for the purpose of fine-tuning system operations. The evaluation is intended to provide:

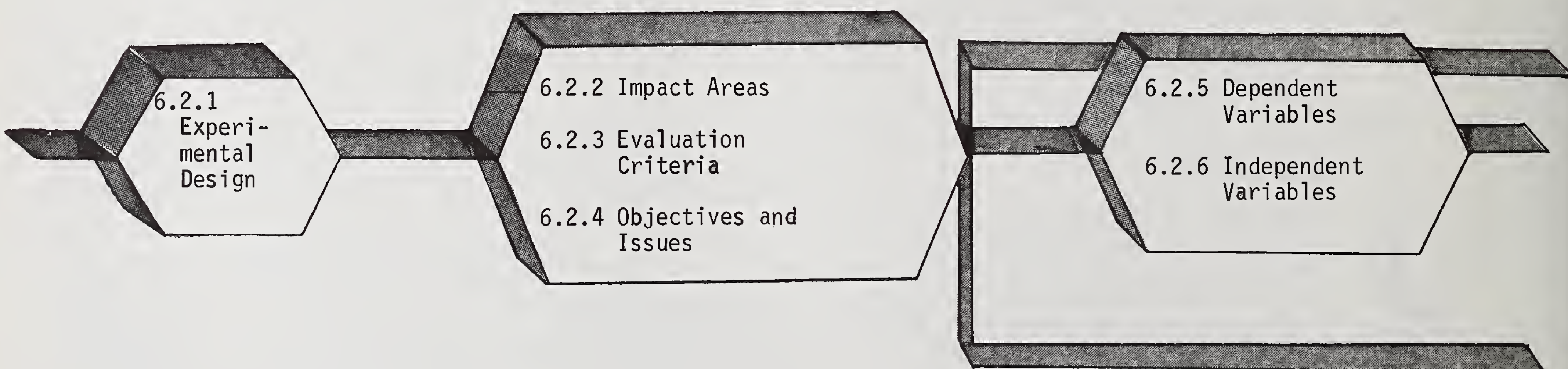
(1) Management with statistical support for long-range system planning;

(2) Policymakers with information regarding the effectiveness of the system in achieving its objectives; and

(3) Other cities with insight into probable consequences of introducing a similar system in a different setting.

This section outlines a structured, time-phased approach to evaluation that:

- Establishes well-defined project objectives;
- Follows a structured systematic approach to developing a quantitative assessment of the project in the light of these objectives;
- Operates within a formal statistical framework;
- Supplies a degree of flexibility for dealing with unforeseen impacts and threats to statistical validity; and
- Provides for the presentation of findings in a manner that is meaningful and understandable to transit operators, administrative officials, and public policymakers.



6.1.1 Evaluation Questions

Questions addressed by the evaluation are listed below:

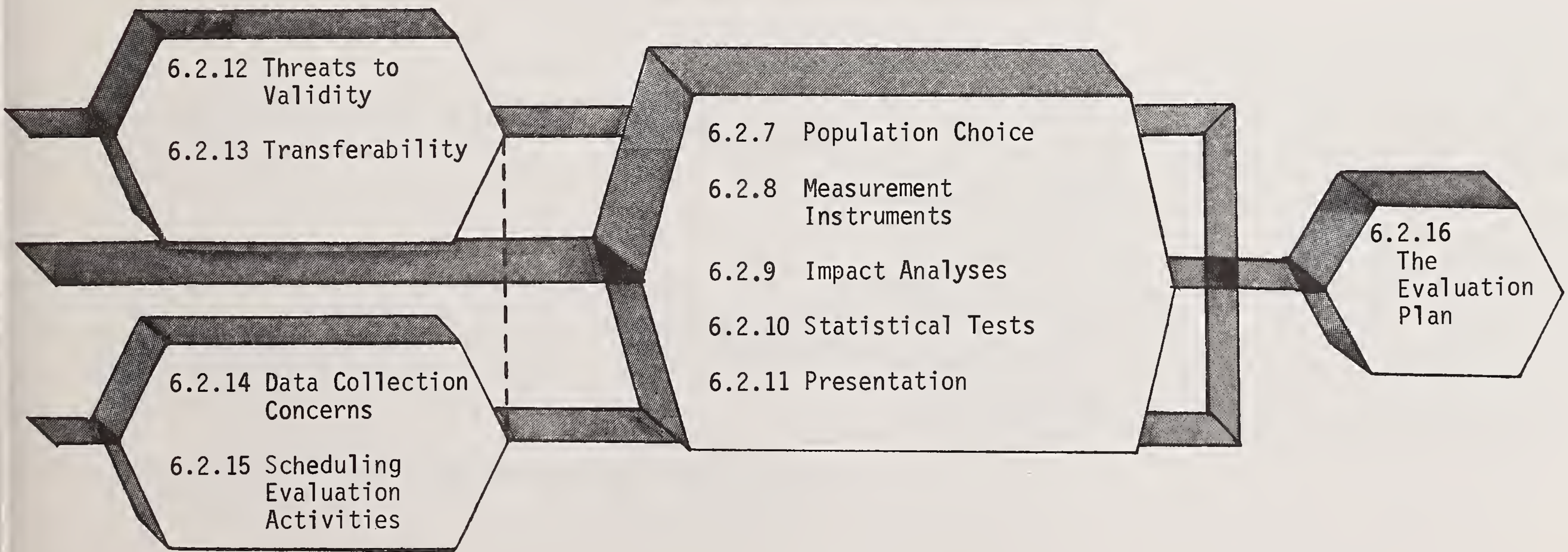
WHAT Is there a change?

HOW MUCH If so, what is the magnitude of change?

WHY What part of the change is attributable to the paratransit system?

HOW What characteristics or factors reinforce or mitigate the change?

In addressing these questions, it is first necessary to document the characteristics of the paratransit system itself, so that any observed impacts may be related to changes in the transportation system. System changes within the control of the operator include service area size, fares, fleet size, response time, operating strategies, etc. Observed impacts may also be the result of factors outside the operator's control. Examples of such factors are the weather, the price of gasoline, and the timing and duration of school holidays. One of the aims of the evaluation process is to document the contributing causes of observed impacts with statistical precision.



6.1.2 Identification and Measurement of Impacts

The impacts resulting from the introduction of a demand-responsive transit service or a change in existing service patterns may affect users, the system itself, the system operator and other local transportation providers, the community and its institutions. The most important impacts to be investigated are those associated with the service's objectives. However, a complete evaluation will include measurements which are not necessarily central to the project's objectives, but which are needed to describe the project's full impact. Consequently, a wide range of potential impacts, both positive and negative, must be considered in any evaluation. Some of these impacts are listed at the right.

IMPACT AREAS

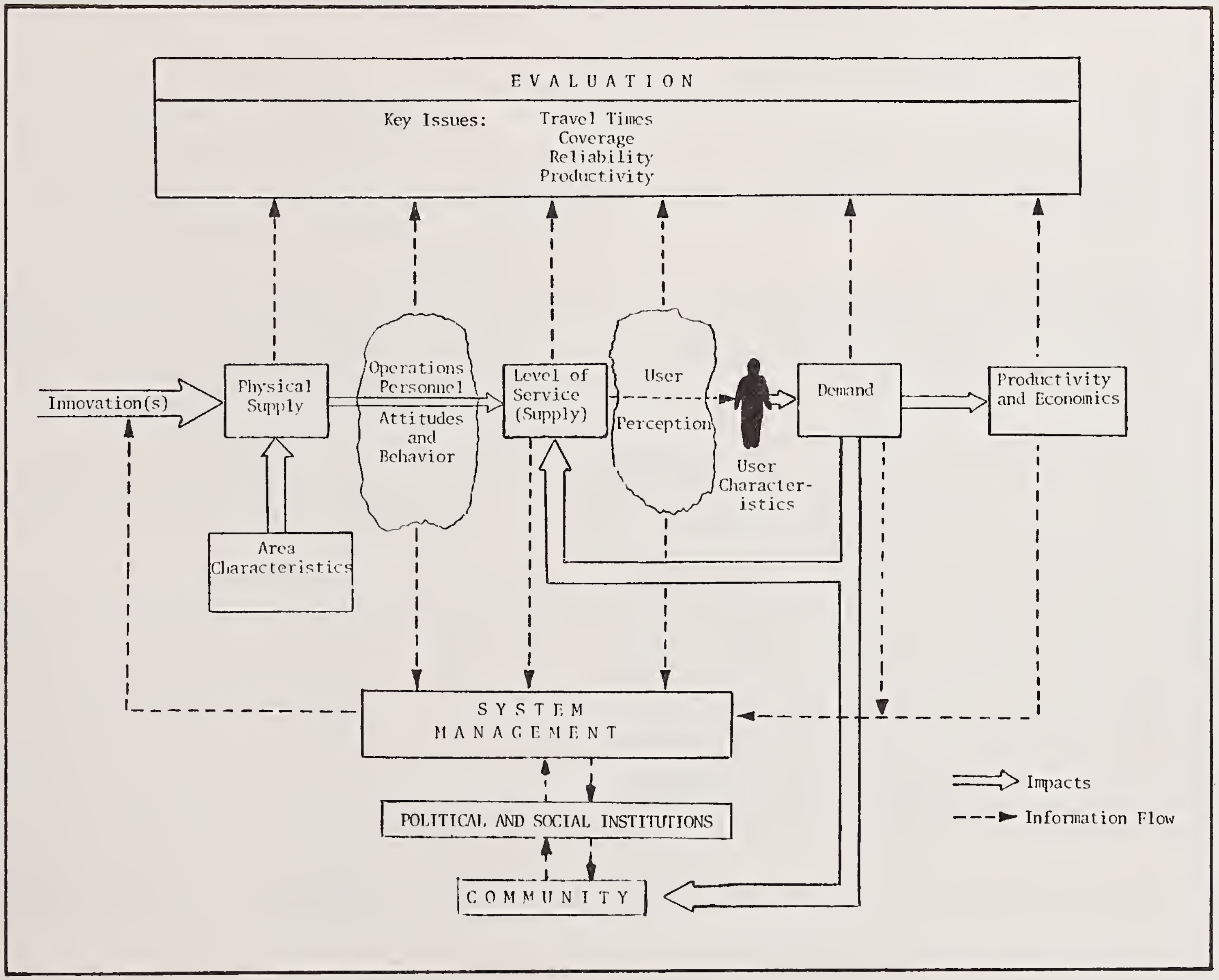
Area	Example
USER	Ridership, mode share, attitudes, wait time, travel time, tripmaking frequency, mobility, accessibility,...
SYSTEM	Reliability, service time, headways, comfort, safety, coverage, response time,...
OPERATORS	Fares, capital and operating costs, revenues, subsidies, productivity, equipment reliability, labor constraints, diversion from other systems,...
COMMUNITY	Energy consumption, air quality, congestion, taxes, public attitudes, safety, institutional roles, financial burden, auto ownership,...

(Source: SYSTAN)

6.1.3 Tracing the Causes of Impacts

Questions of WHY impacts occur and HOW they are affected by factors inside and outside the paratransit system require the evaluator to trace impacts to their source. To aid in analyzing causality, impacts should be examined sequentially: Institutional actions bring about a system change, which makes a new level of transit service available to potential users. Users react to new service offerings, and their responses may, in fact, alter the service levels. Together, the supply and demand parameters will determine the operating efficiency of the system as well as various community impacts. The accompanying exhibit shows how this framework of events was traced in the evaluation of the Rochester, New York Dial-A-Ride demonstration.

CONCEPTUAL FRAMEWORK FOR TRACING IMPACT RELATIONSHIPS



(Source: SYSTAN, Reference 82)

6.2 The Evaluation Plan

The primary characteristics of an evaluation plan are:

(1) Establishment of well-defined project objectives;

(2) Development of a formal statistical framework for obtaining results with local and national significance; and

(3) Presentation of the findings in a manner that is meaningful and understandable to transit operators, transportation planners, and city administrative officials in other localities across the country.

The formal statistical framework that relates project objectives to measured impacts and attempts to ensure the validity and relevance of the measuring process is referred to as an "experimental design." In terms of transportation system evaluation, an experimental design is a "... structured, time-phased plan to permit a quantitative evaluation of an urban transportation project." (This definition reflects the view of the Service and Methods Demonstration Program sponsored by the Urban Mass Transportation Administration.) This usage of the term "experimental design" is somewhat broader than the strict statistical definition, which connotes the existence of a controlled environment for evaluating the outcome of structured research inquiries.

6.2.1 Elements of the Experimental Design

There are nine elements of a complete experimental design:

1. A statement of well-defined objectives specifying the intent of the project in terms of what is to be learned. The objectives are most usefully stated as hypotheses concerning the presumed impacts of the innovation.

2. A description of the variables to be measured that are believed to best characterize, or model, the impacts. In the language of statistics, these are called the dependent variables.

3. Identification of the factors which mitigate or amplify the impacts; that is, the independent variables.

4. A description of the sources of the measured data and the measuring instruments.

5. A description of populations upon which the measurements are taken.

6. A plan for the analysis techniques and statistical tests to be performed on the data.

7. A plan for presenting the findings of the evaluation in an appropriate, intelligible manner.

8. A description of the various factors which may limit the validity of the findings.

9. A time schedule of the measurement and analysis activities.

(A) The Experimental Design Tableau

A complete experimental design will describe the relationships between each of these nine factors. One means of efficiently describing most of these relationships is a tabular array, or tableau, which is shown in the accompanying exhibit. These tableaus show the relationships among the anticipated impacts, or evaluation criteria (Column 1); the objectives of the project (Column 2); dependent and independent variables (Columns 3 and 4); sample populations (Column 5); data sources and measuring instruments (Column 6); analysis (Column 7); statistical tests (Column 8); plan of presentation (Column 9); and a further explanation of the implied causal relationships between the demonstration and the impact under consideration (Column 10). Refer to the following exhibit.

By completing the columns of the evaluation tableau for each hypothesized impact, a total picture of the evaluation process evolves. This makes it easier to develop efficient measurement plans and to consider potential threats to validity when reporting findings.

(B) Uses of the Tableau

Although the use of tableaus provides no magical assurance that the evaluation will be trouble-free, tableaus help to:

6.2.1

SAMPLE EVALUATION TABLEAU

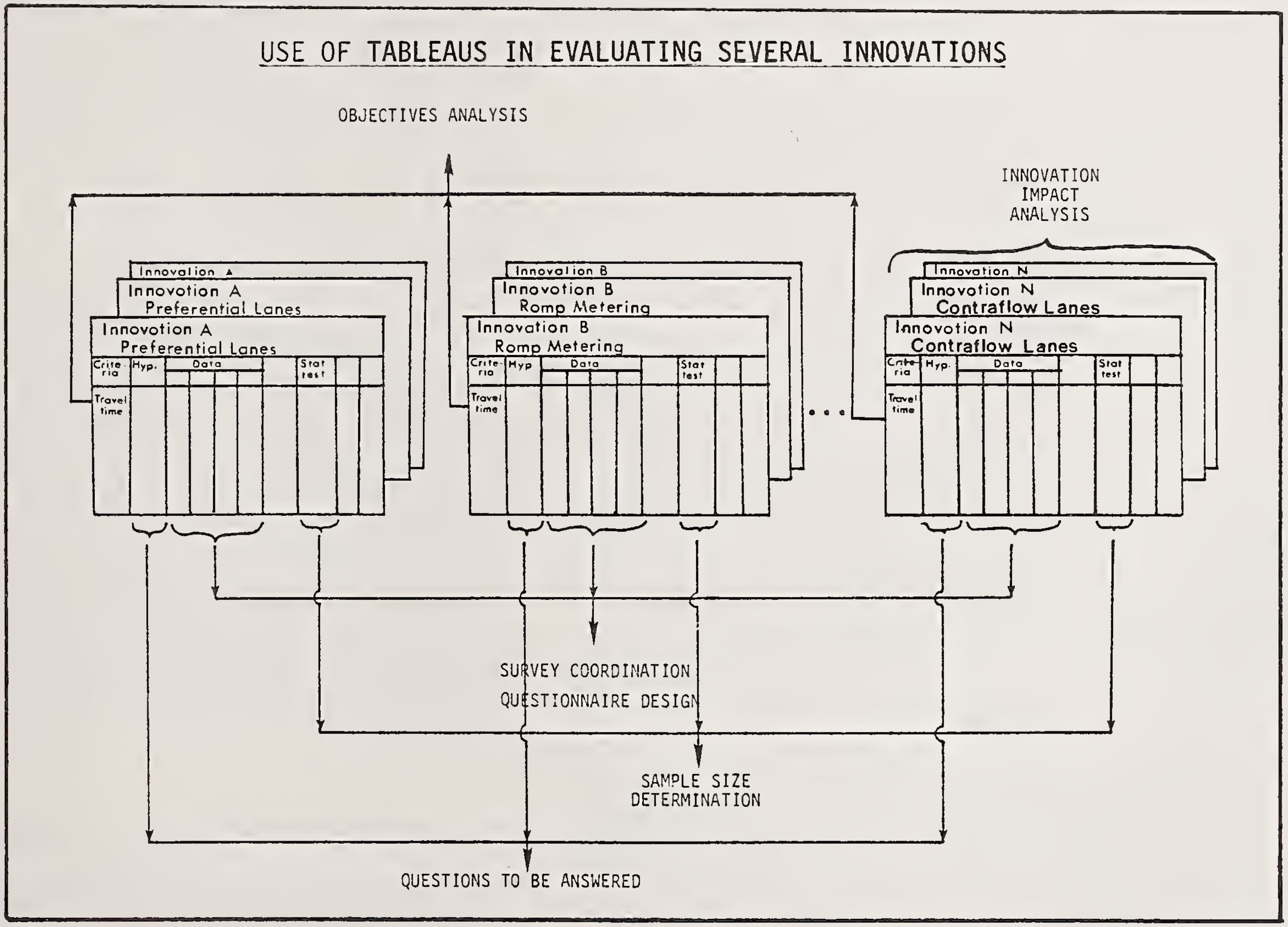
(The El Segundo, California Subscription Service Demonstration)

IMPACT AREA: LEVEL-OF-SERVICE IMPACTS

EVALUATION CRITERIA (1)	OBJECTIVE (2)	DATA: DEPENDENT VARIABLE (3)	DATA: INDEPENDENT VARIABLE* (4)	DATA: POPULATION (5)	DATA: MEASUREMENT INSTRUMENT (6)	ANALYSIS (7)	STATISTICAL TEST (8)	PRESENTATION (9)	EXPLANATION (10)
Coverage	BEEP increases number of employees served by transit	Number of employees living within (1) 1/4 mi. of pick-up points; (2) within 10% of distance to work from route; (3) beyond last pick-up point	BEEP routes (C)	Employees	Employee survey or employer employment records	Compare to total employment with regular transit access, employment with other paratransit access; compare BEEP routes	Chi-square	Show magnitude of expansion and new geographic areas served; list potential market for each route	Regular transit coverage to El Segundo is very sparse and a tiny proportion of the work force now arrives by transit. Paratransit (vanpools, buspools) mostly serves longer-distance commuters. BEEP will be the only transit or paratransit mode available for many short- and medium-distance commuters.
		Access to other transit and paratransit modes							
Travel Time	BEEP travel times are comparable to auto travel times, faster than regular transit	BEEP travel times; access times to pick-up points; auto, regular transit, other paratransit travel times	BEEP routes (C); distance from workplace (C)	BEEP routes	BEEP schedules; on-site measurements; auto speed runs	Compare BEEP travel times to auto, transit, existing paratransit; compare routes	t-test	Show average travel times for different modes according to distance from El Segundo	ECBS routes will only make 5 or 6 stops on each route and travel times should thus be competitive with the auto. Access time to the bus will lengthen travel time slightly, becoming more significant at shorter travel distances. To facilitate comparisons, travel times will be expressed as a speed (miles/hour) when distances are not necessarily the same.
						Correlate level-of-service ratio with distance from workplace	t-test F-test R^2		
	Passenger wait times at pick-up points are short	Passenger wait times; time duration between passenger arrival time and scheduled bus departure time	BEEP routes (c); schedule adherence (U)	Passenger arrivals	Employee survey	Calculate wait times based on passenger & bus arrival times	--	Show difference between scheduled bus arrival times & relation to schedule deviations	Passengers can be expected to arrive significantly before the scheduled bus departure if they perceive a possibility that the bus will leave early of if there is significant variation in access time because of traffic congestion. Otherwise, average wait time will be a function of average bus lateness.
						Correlate wait time with mean & variability of bus arrival deviations	t-test F-test		

*C = Controllable, U = Uncontrollable

(Source: SYSTAN)



(Source: SYSTAN)

1. Provide a systematic approach for developing a comprehensive, complete, and efficient plan in which:

   a. Each objective is assured a thorough assessment;

   b. Each measurement is related to a particular objective; and

   c. Data collection plans are complete and non-redundant.

2. Organize the diverse elements in a readily understandable format, thereby supporting intersystem comparisons.

The complete set of experimental design tableaus for a project also serves as an index of the questions addressed in the evaluation and the parameters to be investigated in addressing these questions. Thus, an observer interested in a specific impact can scan the evaluation criteria column to determine if impacts in that area are addressed in the evaluation. The methodology to be used in analyzing the hypothesized impacts for each evaluation criteria is presented in the remaining columns of the tableau.

6.2.2 Impact Areas (Top Heading)

Impact areas circumscribe the general areas in which impacts are hypothesized. In transit evaluations, impacts can usually be conveniently grouped into five major areas:

(1) Project implementation and physical supply;

(2) Level-of-service (supply) changes;

(3) Travel behavior (demand) changes;

(4) Economic and efficiency impacts; and

(5) Additional social impacts.

6.2.3 Evaluation Criteria (Column 1)

Within each broad impact area, a number of changes are hypothesized. The hypothesized impacts comprise the evaluation criteria which specify the issues to be investigated during the evaluation. Many of the specified evaluation criteria are directly related to the project's objectives, while others reflect issues of interest and are included to provide a full picture of the demonstration's impacts.

6.2.4 Objectives and Issues (Column 2)

Some of the hypothesized impacts correspond directly to the objectives of the demonstration (e.g., increased transit ridership). In other cases, the demonstration's objective is to avoid or minimize a hypothesized change (e.g., increased public financing requirements). Thus, the experimental design objectives are often stated as hypotheses and specify the intent of the project in terms of what is to be measured and learned. For some evaluation criteria, however, the demonstration's objectives may be neutral relative to the hypothesized impacts (e.g., changes in spatial travel patterns). In these cases, the experimental design objective is merely to identify the nature and causes of these impacts.

6.2.5 Dependent Variables (Column 3)

The dependent variables specify the data sets within each evaluation criteria that best measure the hypothesized impacts. For example, if impacts on service reliability are hypothesized, mean schedule deviation could be chosen as a dependent variable to measure the service's reliability.

Some flexibility exists in the choice of measures used to quantify factors of interest, since several variables usually measure certain attributes and several additional proxy measures may be indirect measures of those factors. When possible, the variables with the most widespread usage should be measured in order to improve the transferability of the results. The accompanying exhibit lists the most common measures used to evaluate demand-responsive transit systems.

Another consideration to make when selecting variables is to estimate the cost and convenience of collecting the required data. When the data requirements are massive, it may be wise to substitute related measures for the desired variable, and then infer the level of the desired variable from those proxy measures. A common transit practice is to use the amount of revenues collected to determine ridership levels. More often, however, small measurement samples are taken for variables that are difficult to measure; larger samples are taken for the more easily-measured variables, and used to supplement the smaller data samples when developing conclusions. For example, the telephone operator in a dial-a-ride control room can easily record the promised wait time given to each caller: The variation of this parameter is a reliability issue. The actual system response time is a more significant reliability measure, but it is usually more difficult to measure and is thus recorded less frequently (see Section 6.2.10 on sample sizes).

6.2.6 Independent Variables (Column 4)

The levels of dependent variables are usually affected by several variables, in addition to implementation of the project itself. Demand changes, traffic conditions, weather and related variables may confound the analysis of a project's impacts. These independent variables can sometimes be controlled during the measurement process. For example, measurements can be stratified by time of day to reflect differences in peak and off-peak operating characteristics. In other cases, the situation is outside the evaluator's control, and reflects the frustration of research experimentation outside a controlled laboratory setting.

The effects of independent variables can often be statistically treated with satisfactory results. If sample sizes are large enough, effects of assumed random variables (such as non-seasonal weather) will not apply. In other cases, such techniques as regression analysis or the analysis of variance can isolate the effects of the independent variables. If there is adequate variation in these independent variables, the impacts of the variable of interest (the project's implementation) can then be isolated by subtracting the effects of other variables.

In addition to external factors that affect a project's results, the independent variable column should be used to list those project attributes that may affect the level of the dependent variables being examined. Thus, when considering demand levels, project-related factors such as fares and level of service should also be considered as independent variables, in addition to external factors (e.g., service area characteristics, alternative travel modes available).

From an evaluation perspective, it is usually preferable for the operator to change the independent variables during the project so their effects on the dependent variables of interest can be analyzed. This may be impractical at times because frequent service changes (such as in fares or service area) can confuse users and disrupt their travel habits. However, the analysis of such changes offers an opportunity to fine-tune the system, and provides a basis for accurately estimating the impacts of major service changes. Such experimentation should be conducted judiciously, of course, after carefully considering the potential benefits of the change against the degree of service disruption that would result.

6.2.10
Sample Size

KEY VARIABLES FOR DEMAND-RESPONSIVE TRANSIT IMPACT ASSESSMENT

Evaluation Criteria	Variables
Level-of-Service Measure:	
Coverage	Service area population (demand-responsive services); population within 1/4 mile of bus route (fixed-route services); activity centers served (shopping centers, schools, employment centers, hospitals, other public services); operating hours; vehicles/square mile.
Service Availability	Percent of valid requests unable to be served.
System Response Time	Mean time between calling for service and pick-up; advance reservation notice requirement.
Ride Time	Mean passenger on-board time; passenger travel speed (trip distance/on-board time).
Access/Egress	Mean access and egress time; mean access and egress distance.
Total Travel Time	Random access for door-to-door services = system response time + ride time; planned access for door-to-door services = pick-up deviation + ride time; random access for fixed-route service = access time + 1/2 headway (wait time) + ride time + egress time; planned access for fixed-route service = access time + arrival time variance factor (wait time) + ride time + egress time variance factor (wait time) + ride time + egress time.
Transfer Time	Mean and standard deviation of transfer time
Safety	Accidents per million vehicle-miles.
Headways	Mean time between fuses on fixed route services.
Service Reliability	System response time standard deviation; mean and standard deviation of pick-up deviation; mean and standard deviation of schedule deviations.
Demand Response:	
Ridership	Weekday and annual ridership.
Market Penetration	Ridership/capita; ridership/eligible population.
Demand Density	Demands/square mile/hour.
Demand Response: (continued)	
User and Trip Characteristics	Distribution of riders according to: age, sex, automobile availability for trip, household automobile ownership, household income, trip purpose, alternative modes if service didn't operate, usage frequency for different travel modes, time trips taken; percentage of trips to or from major activity centers.
Mode Shares	Distribution of trips by different modes.
No-Shows	No-shows as a proportion of all trips.
Operating Efficiency	Vehicle-miles/vehicle-hours (operating speed); dwell times at pick-up and drop-off points.
Revenue Recovery	Revenue/passenger; revenue/passenger-mile; revenue/costs.
Other Social Impacts:	
Environmental Effects	Change in vehicle-miles traveled.
Financial Subsidy	Operating deficit/passenger; operating deficit/capita.
Efficiency and Economics:	
Equipment Performance	Out-of-service time/total operating time; mean time between failures; mean time to repair failures; in-service breakdowns.
Vehicle Utilization	Service-miles and service-hours/vehicle; peak service requirement/fleet size.
Labor Productivity	Service-hours/pay-hours; service-miles and service-hours/worker.
Operating Costs	Operating cost components: operator salaries, maintenance, fuel and oil, control room salaries, administration and marketing, depreciation, and other; driver wage scale.
Cost Efficiency	Costs/vehicle-hour; costs/passenger; cost/passenger-mile.
Service Utilization	Passengers/vehicle-hour; passenger-miles/vehicle mile (average load factor).

(Source: SYSTAN)

6.2.7 Choice of Populations (Column 5)

An important element of the experimental design tableau is the column which identifies the populations subjected to measurement, or the "sampling frame" of the experimental design. For most transportation innovations, impacts will be limited to a specified target population, so that a comprehensive areawide data collection process may be unnecessary. In such a case, the smaller target population group would be subject to a more detailed data collection in the hope that this would help to identify causal linkages by providing a detailed and exhaustive data base for inferences regarding the chain of causality. Some areawide totals will be useful, especially in answering questions regarding general changes and in generating data of interest to other cities.

It is not enough merely to define in very precise terms the population to be sampled. It is equally important to assure that every population element has a known probability of being included in the sample. A "sampling frame" is a structuring of a population element for measurement purposes. For example, all frequent transit users can be reached through station or on-board sampling. On the other hand, the population of all non-users is more difficult to structure and, hence, to sample. It will often be desirable to stratify the samples into subsamples with homogeneous characteristics. While it may be possible to specify the sampling frame and selection procedure to assure randomness and minimum sample error for the total sample, the sampling frame for the subsample may not be known in advance of the survey. One means of resolving this difficulty is to select very large samples. An alternative procedure is sequential sampling, using a preliminary survey to define the sampling frame for the subsamples. In some cases (e.g., when the subsamples are to be defined as socioeconomic characteristics), the sampling frame may be defined by census data.

6.2.8 Measurement Instruments (Column 6)

The measurement instruments specify the techniques to be used to collect the required data, such as on-board surveys of passengers and on-board measurements of travel speeds. Measurement instruments and sample sizes must be selected on the basis of estimates of the level of change that is to be discerned. For example, mechanical traffic counters are generally accurate only to plus or minus ten percent. If a smaller change is anticipated as an impact, it should not be assumed that traffic counters can be used to achieve the desired accuracy.

The accompanying list identifies the more common measurement instruments used for demand-responsive transit evaluations. There are many potential data sources, but their costs vary considerably. In general, the labor-intensive data collection techniques are the most expensive, especially those which require personnel to be on-board buses or in the field monitoring operations. Unfortunately, much useful data can only be collected in this way, including travel times and reliability data and user information of travel through surveys. Operators can greatly reduce their data collection costs if the drivers collect much of the required data. This can eliminate the need for additional workers to keep track of passenger boardings and distribute and collect on-board surveys.

TYPES OF MEASUREMENT INSTRUMENTS AND OTHER DATA SOURCES FOR DRT EVALUATIONS

Measurement Instrument/ Data Source	Types of Data Collected
Control Room Transaction Records	Service requests, service requests not served, call-in time, promised pick-up time, cancellations, spatial and temporal trip characteristics.
User Comment Logs	Number and types of user comments.
Information Request Logs	Number and types of information requests.
Dispatcher and Driver Logs	Vehicle-hours and vehicle-miles operated, vehicles in service, tour assignments, no-shows, ridership, in-service breakdowns, accidents.
Maintenance Logs	Equipment out-of-service time, type of breakdowns.
Accounting Records	Operating costs, revenues.
Driver Work Schedules	Scheduled vehicle-hours, pay-hours.
Control Room Observations	Telephone hold and service times.
On-Board Observations	Fixed route ridership, schedule reliability, pick-up and arrival times, dwell times.
Field Observations	Fixed route ridership, schedule reliability, transfer times.
User and Non-User Surveys (on-board, home, mail, phone, activity site)	User and non-user characteristics and attitudes, trip characteristics.
Management and Worker Surveys	Institutional roles and impacts, attitudes.
Transit Schedules	Estimated travel times and speeds, headways.
U.S. Census Data	Site demographic and economic characteristics, population in service area and within one-quarter mile of fixed routes.
Traffic Department Data	Traffic volumes, congestion areas, automobile travel speeds.

(Source: SYSTAN)

6.2.9 Impact Analysis (Column 7)

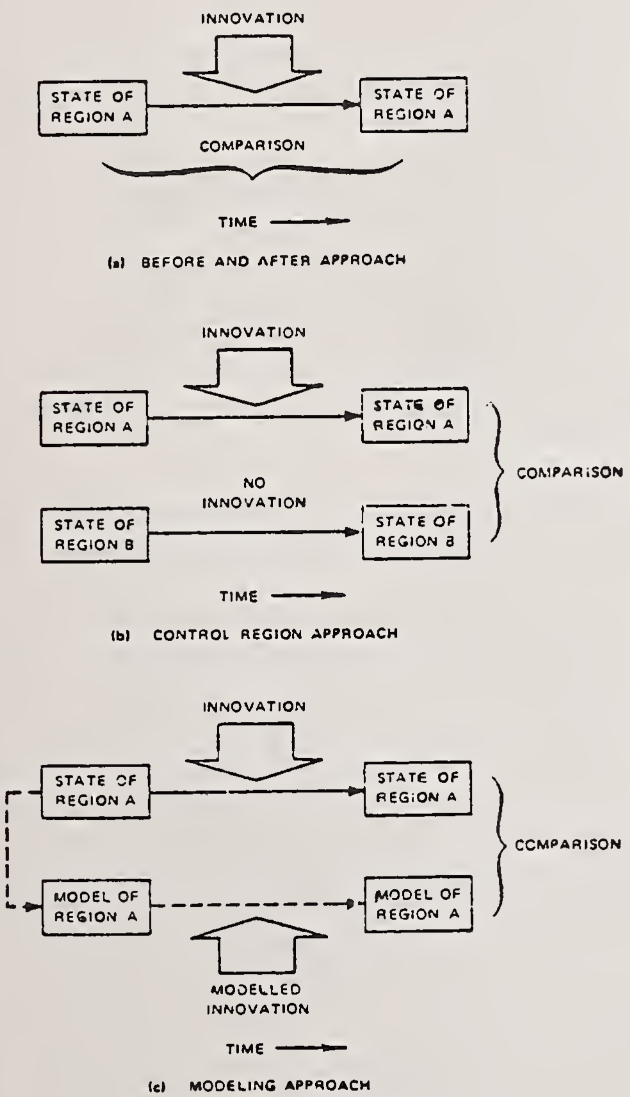
(A) Comparison Strategies

In order to determine whether there have been changes in the levels of dependent variables, a comparative analysis approach is required. These changes, or impacts, may be measured by different types of comparison. Three general comparison strategies are common: comparisons at different points in time; comparisons of different geographic regions or population groups; and comparisons between real and hypothesized systems. These three common comparison strategies are shown in schematic form in Exhibit A through C on the following page.

(i) Before-After Approach. The first approach, illustrated in Exhibit A, compares system states before and after the introduction of the project or some feature of it. This is the most commonly-used technique in transit evaluations. The methodological difficulty with this approach is that changes may be caused by many factors, and it is often difficult to distinguish transportation-induced changes from those caused by other factors. Moreover, transit operators sometimes introduce simultaneous changes, and the before-after approach often does not allow the evaluator to isolate causes.

(ii) Control Region Approach. The above difficulties suggest a second comparison approach which would relate the study group or region to a similar region which does not receive a transportation innovation. The second region is analogous to the traditional experimental control group. It is assumed that the two regions are subject to the same forces, except for certain transportation innovations, and that comparing both regions will reveal the effects of these innovations. The methodological difficulty with this approach is that no two regions are absolutely comparable.

ALTERNATIVE COMPARISON STRATEGIES



(Source: SYSTAN)

<u>(iii) Modeling Approach</u>. The third comparative approach is based on the concept that if one innovation (e.g., a demand-responsive transit service) were not introduced, another would have been (e.g., fixed-route bus service). Therefore, the correct comparison is to relate the state of the community "after" the various alternatives have been introduced. Since it is seldom possible to introduce several major innovations in distinct time frames, this comparison requires a model of the community "after" the hypothetical introduction of those alternatives which are not actually implemented. Because the modeling of communities is not an exact science, this approach can hardly be said to be free of methodological difficulties.

Since none of the above comparative approaches are totally satisfactory, an evaluation should rely on all of them to some extent. The simplicity of before/after analysis makes this the most attractive approach; however, it should be supplemented by the other approaches where feasible and appropriate.

(B) Tracing Impact Causes

The evaluation analysis should also determine why impacts occurred as they did. Variable changes can result from complex interactions among several factors (the independent variables of Column 4), with the project serving as a catalyst that changes some or all of these independent variables. In such cases, it is necessary to construct a causal model that incorporates all of the variables which are hypothesized to cause a change in the dependent variable of interest. The models are then used to determine the relative effects of the independent variables on the dependent variables.

When adequate quantitative data exists, established statistical techniques can be used to create the causal model. In particular, the techniques of regression, analysis of variance, and analysis of covariance can isolate the relative impacts of different variables on a single dependent variable. These techniques can be used either in a simple fashion, in which all of the independent variables are assumed to directly influence the dependent variable, or in a more complex fashion, in which some variables affect the dependent variable in an indirect fashion by changing other variables that have a direct effect. An example of the more common latter case occurs when the acquisition of new buses increases the proportion of scheduled runs that are operated, which in turn improves service reliability. Path analysis, an extension of regression analysis, is a useful technique when multi-chain causal models are hypothesized.

The construction of statistically precise causal models that accurately predict variable levels is an ideal that is frequently unachievable in actual practice. This problem is caused by two main factors: First, the web of causation may be much too intricate to model effectively, and many factors may not be readily identified or quantified. This is especially true when behavioral issues are being analyzed. Second, there may be insufficient variable variation to determine any trends (e.g., fares or service levels do not vary enough during the project's life to determine their effects on demand).

Where quantitative models are ineffective for explaining impacts, a qualitative causal model may often be developed based on attitudinal surveys of users, non-users, or demand-responsive transit employees. Attitudinal data may also suggest new hypotheses for quantitative testing. Users and non-users can be asked to indicate when they use or do not use the service in order to explain why demand occurred as it did. Their attitudes toward service level attributes will also indicate whether the quantitative standards being used to evaluate service quality are realistic. Likewise, management officials and workers can often offer insights into the implementation and operation processes that cannot be detected from quantitative data. For these reasons, the attitudes of these groups toward the service should be carefully documented as part of the evaluation.

6.2.10 Statistical Tests (Column 8)

(A) Levels of Significance

When quantitative estimates are made, the results should be reported with some measure of statistical significance in order to indicate how reliable they are. In estimating the value of a variable from a sample, the result should include the computed value and a "confidence range" that describes the range in which the true value of the variable probably lies. For example, passenger wait times might be measured from a sample and reported as a mean wait time of ten minutes with a 95% confidence range of plus or minus two minutes. This indicates that the most likely true value of average wait time is ten minutes, and there is a 95% probability that the true value lies between eight and twelve minutes (the confidence range). A smaller confidence range would indicate that the computed average wait time is more likely to be accurate.

When comparing variables, changes or differences should be reported with a significance level. This level reflects the probability that the measured difference is based upon chance rather than a fundamental difference between the variables (that can perhaps be attributed to a specific cause). If two statistics are said to be different at a significance level of .10, it means that there is a 10% chance that the true values of the underlying variables are the same. For example, if weekly ridership during a defined period following a service change is greater than ridership during the period preceding the change at the .10 significance level, it means that there is a 10% chance that the observed difference in ridership between the two periods reflects only the normal fluctuation in ridership between weeks rather than some fundamental difference between the two periods (such as that caused by the service change). Thus, the lower significance level reported, the less chance there is that no real change in the variable occurred. The causal interactions between variables are also reported with a significance level; in this case, it reflects the probability that the independent variable really has no causal effect on the dependent variable.

COMMON ANALYSIS TECHNIQUES AND STATISTICAL TESTS

Question or Hypothesis	Example	Analysis	Statistical Test for Determining Significance
What is the level of Variable A?	What is the average passenger travel time on DAB?	Calculate mean from sample	Confidence limits using t-test
The mean of Variable A is different from, greater than, or less than a standard or the mean of Variable B	Ridership has increased following the addition of new vehicles	Compare variable means or variable mean with a standard	t-test
The variability of Variable A is different from, greater than, or less than a standard or the variability of Variable B	The variability of system response time is less in the off-peak than in the peak period	Compare standard deviations or variances	F-test
Variable A is related to Variable B	System response time increases when demand density increases	Correlation; regression; analysis of variance, covariance	t-test F-test F-Test
The categorical values of Variable A are different from the categorical values of Variable B	The age distribution of riders (under 18, over 65, etc.) differs between the subscription and dial-a-ride services.	Cross-tabulation	Chi-square test

(B) Sample Sizes

In discussing quantitative results, a common rule is to reserve the term "significant" for those findings in which a significance level is less than .05 or .10 (i.e., there is only a 5% or 10% chance that the finding is based on change). The significance level reported depends upon the sample size, the variability of the parameters being analyzed, and the magnitude of the measured difference. Results can be stated with greater certainty (i.e., lower significance levels for the same measured change) when the sample size is larger or the variability is lower. The evaluator usually has no control over the variability of the parameter being measured (such as day-to-day variations in service reliability), but he may often control the sample size (the number of days that service reliability is measured). Thus, the validity of evaluation results is closely linked to the issues of sample size.

Some evaluation data will be based on full samples, and sample size selection is not a consideration. Such data typically includes operating costs and revenues, phoned service requests, ridership (if recorded by the driver or control room personnel), vehicle-hours and vehicle-miles, and other operational data that is continuously collected. However, several key data elements will typically be derived from samples. These include travel time and service reliability data, telephone hold and service times, fixed-route ridership data and user characteristics. The sample size required to achieve a given level of accuracy is very sensitive to variability of the variables being measured. To estimate the mean of a variable within plus or minus 5% with 95% confidence, the required sample size would be under 100 if the variance is 25% of the mean, but nearly 900 if the variance equals 75% of the mean. The same data may also be used for different analysis and differing levels of accuracy may be desired. This further complicates the selection of appropriate sample sizes. For example, service quality might be expected to undergo changes of varying magnitudes because of different supply changes made, and it might be necessary to have more accurate results when analyzing the smaller changes.

For the above reasons, it is difficult to establish specific guidelines for sample sizes. In selecting sample size, the evaluator should consider the following issues:

(i) Data Collection Cost. Field data such as service reliability measurements, travel times, etc. are often very expensive to collect unless drivers can collect these data. The cost of collecting different sample sizes should therefore be estimated before making a decision.

(ii) Uses of the Data. The evaluator must examine what the data will be used for. If the data will only be used to characterize the system's operation with little comparative analysis intended, modest sample sizes are usually sufficient unless a high level of accuracy is needed to demonstrate that a specific standard has been achieved. In such a case, a more formal statistical testing procedure should be employed to determine the appropriate sample size.

Sample sizes should be larger when used to analyze how variables change as a result of service modifications. If the anticipated changes are small, very large samples may be required to detect them accurately.

(iii) Variability of Data. As indicated above, high variability requires larger sample sizes for the same level of accuracy. Variability can also occur along different time frames and sample sizes may have to be enlarged to account for this. A prime example is the variation in ridership and service quality that occurs within the course of a day (between the peak and off-peak periods, for example) and also between days. When measuring an attribute such as service reliability, one must not only sample pick-up deviations over the course of a day, but data from different days must be sampled unless it can be shown that there is insignificant variation between days.

(iv) Importance of Data. The relative importance of accurate data also needs to be addressed in determining sample sizes. When sampling data such as telephone response times, it may only be necessary to gain a general sense of the situation; that is, to determine whether the number of customers put on hold before being served is under 10% or closer to 50%. On the other hand, very accurate ridership data are usually desired, since the level of demand is a basic evaluation concern in almost any system. If subsidy levels are tied to ridership, there is an additional need for highly accurate data.

(v) Perishability of Data. In many cases, small data samples can initially be collected and analyzed, and the evaluator can determine if the results are statistically valid at the level of accuracy desired. If the results do not meet these standards, additional data can then be collected to increase the sample size and raise the level of accuracy. However, this cannot be done in cases where the data are perishable, that is, where the situation is changing so rapidly that additional measurements will not be possible.

The most common example of perishable data occurs when information is collected before a project is implemented. In such cases, sample sizes should be sufficiently large to provide a safety factor in case there is a later change in the accuracy desired. Also, it is frequently desirable to stratify data into subsamples (such as by time of day or market group), but this may only be realized after the data have begun to be analyzed and the distinction between these subsamples becomes apparent. Therefore, sample sizes for perishable data should be large enough to accommodate such unforeseen stratifications later.

6.2.11 Presentation (Column 9)

Evaluators of demand-responsive services should anticipate that a diverse group of persons will be interested in the results. Transportation policymakers, planners, and operators, both from the local area and other cities, are likely to study the evaluation reports. Since demand-responsive transportation is a relatively new concept, transportation researchers are also likely to use the results to add to the state of knowledge about system performance. Consequently, evaluation reports should not only list the major findings, but also provide the detailed data and analytic results upon which these findings were based. The report should also discuss those factors which might limit the transferability of the results to other locations. Organizing the report into an executive summary of findings, a main body that supports the findings, and technical appendices helps to insure that the report includes all pertinent information.

6.2.12 Threats to Validity

Attention to the need for statistical precision will help to insure that the evaluation results are valid. However, there are many factors which threaten the ability of the analyst to draw correct inferences from project results. These threats to validity can be conceived as falling into two groups: those that threaten <u>internal</u> validity and those that threaten <u>external</u> validity. Internal validity is the ability to discern correctly the local impacts of the project. External validity is the relevance of correctly perceived local impacts for predicting impacts of similar systems in other metropolitan areas. Lack of internal validity typically implies lack of external validity, except by coincidence. The converse is not necessarily true.

Threats to validity are not all statistical in nature; that is, the threats are not all due to sampling factors. Many are due to the process of measurement and its effect on the environment or on those variables being sampled. Others are due to the inability to isolate the project's effects from the multitude of other factors which constantly change the environment and activities in a dynamic setting such as a city.

In some cases, threats to validity may be lessened by scheduling innovations and measurements so they do not interfere with each other, or by the careful definition of control groups. Although the countering of threats to validity is a paramount goal of the evaluation plan, the ability to accomplish this in a real setting (as opposed to a laboratory setting) is greatly constrained. Therefore, a second objective is to describe the threats comprehensively so that hypotheses may be made and tested with the full knowledge of the factors which may limit the validity of the results.

6.2.12

Different threats to validity are listed at the right and discussed in subsequent subsections. The classification process lists ten threats to internal validity and two threats to external validity, several of which overlap with each other.*

(A) Threats to Internal Validity

Prominent threats to internal validity may be categorized as follows:

(i) Exogenous Factors. Threats of this nature include all external events, not associated with the transportation system, which change attitudes or have a decided impact on life and the economy within the region. Exogenous factors that affect the outcome of a project cannot be specified ahead of time. Events such as a gasoline shortage or an economic recession are examples of exogenous events that would strongly influence a transit project. The most effective technique for handling exogenous factors is to define control groups. By observing how other isolated elements of a transit system are affected by a gasoline shortage, for example, it may be possible to estimate its impact on the demand-responsive transit system being studied.

(ii) Maturation. Maturation is the effect of time independent of specific events. It includes existing trends in population and economic growth and the effect of learning by users, operators, etc.; it is analogous to "wound healing." Studying a project for a lengthy period until a steady-state period is reached, or the impact of the external trend can be identified, is the most effective technique for dealing with this threat.

* Adapted from Campbell, Donald T. and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research, Rand-McNally and Company, Chicago, 1970.

THREATS TO INTERNAL VALIDITY

	Threat	Examples
1.	Exogeneous Events	Gas Crisis, School Holidays, Rainy Season
2.	Maturation	Transient Learning Period, Population Increases
3.	Measurement	Survey Sharpens Awareness Among Interviewees
4.	Time Interference	Simultaneous Introduction of Two Innovations
5.	Instrumentation	Accuracy of Measuring Instruments
6.	Variable Selection	Citations as a Proxy for Violations
7.	Population Selection	Home Interview Sampled CBD-Destined travelers, while Other Surveys Sampled Corridor Users
8.	Statistical Regression	Erroneous Early Measurements
9.	Mortality	Disappearance of Home Interview Panel
10.	Selection Interaction	Second Order Effects

THREATS TO EXTERNAL VALIDITY

1.	Unique Locale	University town, High incidence of transit-dependence
2.	Experimental Conditions	Media attention to experimental nature of operation; Public awareness of evaluation process; Simultaneous changes of key operating parameters

(Source: Campbell and Stanley)

(iii) Measurement. This threat deals with the effect of measurement on the object being measured and is analogous to the Hawthorne effect in management or Heisenberg's Uncertainty Principle in physics. Such a threat may intrude on attitude surveys of human populations, wherein the survey itself may affect attitudes by sharpening awareness, etc. The measurement process should therefore be designed to be as unobtrusive as possible (e.g., monitoring driver behavior by following buses rather than having observors on board).

(iv) Time Interference. Threats due to time interference relate to the interaction of two or more innovations which tend to obscure the individual effects of each. Even when innovations are separate in time, the transient response to each may interfere with a subsequent innovation. This threat to validity is best handled by separate scheduling of those innovations that are expected to interfere with one another.

(v) Instrumentation. Errors introduced by the measurement instruments include hardware-introduced errors, biases introduced by interviewers or by the interview environment, and human errors in counting.

(vi) Variable Selection. Choosing a variable which presumes to measure a certain characteristic when, in fact, it does not is another threat to validity. Since there are usually several variables, including proxy measures, that can be used to measure the achievement of an objective, the evaluation should focus on those with the least ambiguity and greatest general usage. These are outlined in 6.2.5.

(vii) Population Selection. This factor includes all errors in observed variables attributable to sampling from a population other than the one specified. It also includes errors in logic in assigning a characteristic to a group. For example, the characteristics of all potential users of a service (such as a population registered to use a target market service) are often confused with the characteristics of the actual ridership population, which should be weighted in favor of the more frequent users.

(viii) Statistical Regression. This effect is due to selection of a population based on some previously-measured characteristic which in itself is a sampled measurement subject to sampling errors. For example, if the income level for a certain geographic area is determined by sample and that sample happens to understate the true population income, subsequent measures of income within the region would probably display an increase in income when in fact it had not occurred. This factor is a special type of selection error combined with repeated measurements on the same variable.

(ix) Mortality. Mortality defines all errors caused by changes in the population being considered, such those due to migration of study area population groups or loss of survey panel members due to attrition or migration. If the population lost is significantly different from the one retained, before-after comparisons may be invalid.

(x) Selection and Interaction With Other Factors. Threats of this nature describe the situation in which different population groups may be more or less prone to the effects of other threats to validity. For example, groups with low education levels may be more influenced by repeated interviews than more highly-educated groups, due to the awareness that such interviewing generates (a case of selection-measurement interaction).

(B) Threats to External Validity

All threats to internal validity also threaten external validity but, in addition, two types of factors

6.2.5
Dependent Variables

specifically affect the transferability of project results from one locale to another. The first is the uniqueness of any location, and the second occurs when the project is promoted as an experiment where continuation is contingent upon a positive evaluation:

(i) Uniqueness of Locale. This factor relates to the question, "Does the locale have characteristics so unlike other regions that impacts measured there cannot be expected in other cities?" Local transportation, geographic, institutional, economic and demographic factors must be studied to determine whether they strongly influence the project's outcome.

(ii) Experimental Conditions. This considers the question, "Are there any arrangements resulting from the project's experimental nature that affect the results?" For example, a long measurement process may affect the project, the media may give it special attention, and users may have raised or lowered expectations because of the project's experimental nature. Frequent service and operational changes may also occur as part of the search for an optimal strategy, and this may affect user response to the project.

6.2.13 Transferability of Results

Threats to external validity impair the ability of officials in other locales to translate demonstration results for their own use. In developing an experimental design, however, it is not sufficient merely to avoid threats to external validity to insure transferability of results. Rather, positive steps must be taken to provide a common basis for understanding on the part of transit operators, transportation planners, and city administrative officials in other localities across the country.

Several steps may be taken at the outset of an evaluation to help insure that findings will be useful to other urban areas and governmental jurisdictions. These include:

1. Developing general and specific data within an urban classification scheme which "locates" the demonstration service area with respect to other urban areas;

2.1.4
Data Elements Discussion in an Urban Setting

2. Establishing a structured evaluation framework which reflects the urban classification scheme and anticipates the questions of interest in other areas;

6.2.1
Structured Approach to Evaluation

3. Defining system parameters and expressing impact findings in a manner that can be directly interpreted by other jurisdictions; and

6.2.5
List of Commonly Used Impact Measures

4. Relating findings to the performance of current and past demand-responsive systems in similar areas, noting whether the results appear to confirm or deny trends reported in other analyses, and whether any unique project or site characteristics appear to explain similarities and differences.

Part 3
Current Trends in Existing Demand-Responsive Systems

6.2.14 Data Collection Concerns

Data collection efforts represent a significant cost in any evaluation. The experimental design tableaus of Section 6.2.1 help to eliminate redundancy and promote efficiency in data collection by providing a single source which can be consulted regarding a project's data requirements. The information in this source can be consolidated by following the four data columns through all of the tableaus to assemble a listing of all measurements that need to be taken and the data that must be collected by each measurement. This material should then be aggregated into a table that specifies how, when, and where all data elements are to be collected. Finally, a data collection schedule and budget estimate should be developed based on this information.

(A) Steps Toward Efficient Data Collection

In addition to organizing the data collection process through the use of experimental design tableaus, data collection efforts may be made more efficient by:

- Assuring that each data collection activity and measurement instrument is designed to collect all data possible for all objectives. This includes searching for ways that one data collector can collect multiple data elements. A person riding a bus, for example, could record pick-up and arrival times and also distribute and collect user survey forms.

- Preparing data collection checklists that enable the person responsible for evaluation and data collection to monitor the progress of all data collection activities. This will help assure that all required data are collected.

6.2.1
Experimental Tableau

SAMPLE DATA CHECKLIST

CHECKLIST
FOR
PRE-IMPLEMENTATION MEASUREMENTS
SANTA MONICA PREFERRENTIAL LANE EVALUATION

Measurement: On-ramp Queue Lenghts

Location:	Santa Monica Freeway Eastbound (A.M. Peak)	Santa Monica Freeway Westbound (P.M. Peak)
Lincoln Boulevard	( )	( )
Cloverfield Boulevard	( )	( )
Bundy Drive	( )	( )
La Cienega Boulevard (Southbound ramp)		( )
Washington Boulevard	( )	( )
Crenshaw Boulevard	( )	( )
20th Street (Hoover Street)		( )
Vermont Avenue		( )
Arlington Avenue		( )
Fairfax Avenue		( )
Robertson Avenue		( )
Western Avenue		( )

Sampling Method: Queue legnths will be measured on at least two different days during peak hours at 15 minute intervals at the above minimum locations. The queue lengths will be measured in both the reserved and unreserved access lanes and combined with the metering rate to compute mean delays at each on-ramp. All vehicles in the queue shall be counted durnig each observation period.

Source: SYSTAN Evaluation Plan for the Santa Monica Freeway Preferent- Lane Project.

- Using data collection devices which render the data in "machine-readable" form or in a form that may easily be converted.

- Designing "self-reporting" data collection processes whereby the persons being observed aid the process by recording transportation data. Using self-completion surveys rather than interviewing users is one example.

- Scheduling data collection procedures to coincide with measurements and observations currently made on a regular basis by local agencies in the area.

- Utilizing well-chosen samples sufficient to provide reasonable levels of confidence given the uncontrollable uncertainties in the environment.

- Scheduling data collection procedures to coincide with measurements and observations currently made on a regular basis by local agencies in the demonstration area.

(B) The Problem of Missing Data

The experimental design must often cope with the problem of data which may be missing or unavailable for a number of reasons. Demonstration activities may have begun prior to completion of a comprehensive evaluation design plan; it may be desirable to evaluate an innovation after the fact; data may not be obtained for physical reasons or may be classified as proprietary; data collection may be prohibitively costly (such as that which requires destructive testing); or perishable data may be lost as a result of events outside the control of the evaluator. In any case, there are a number of solutions to the problem of missing data. Among them are the following:

(1) Formal statistical experimental designs may be used which permit statistical evaluation of incomplete data sets (such as Latin Square);

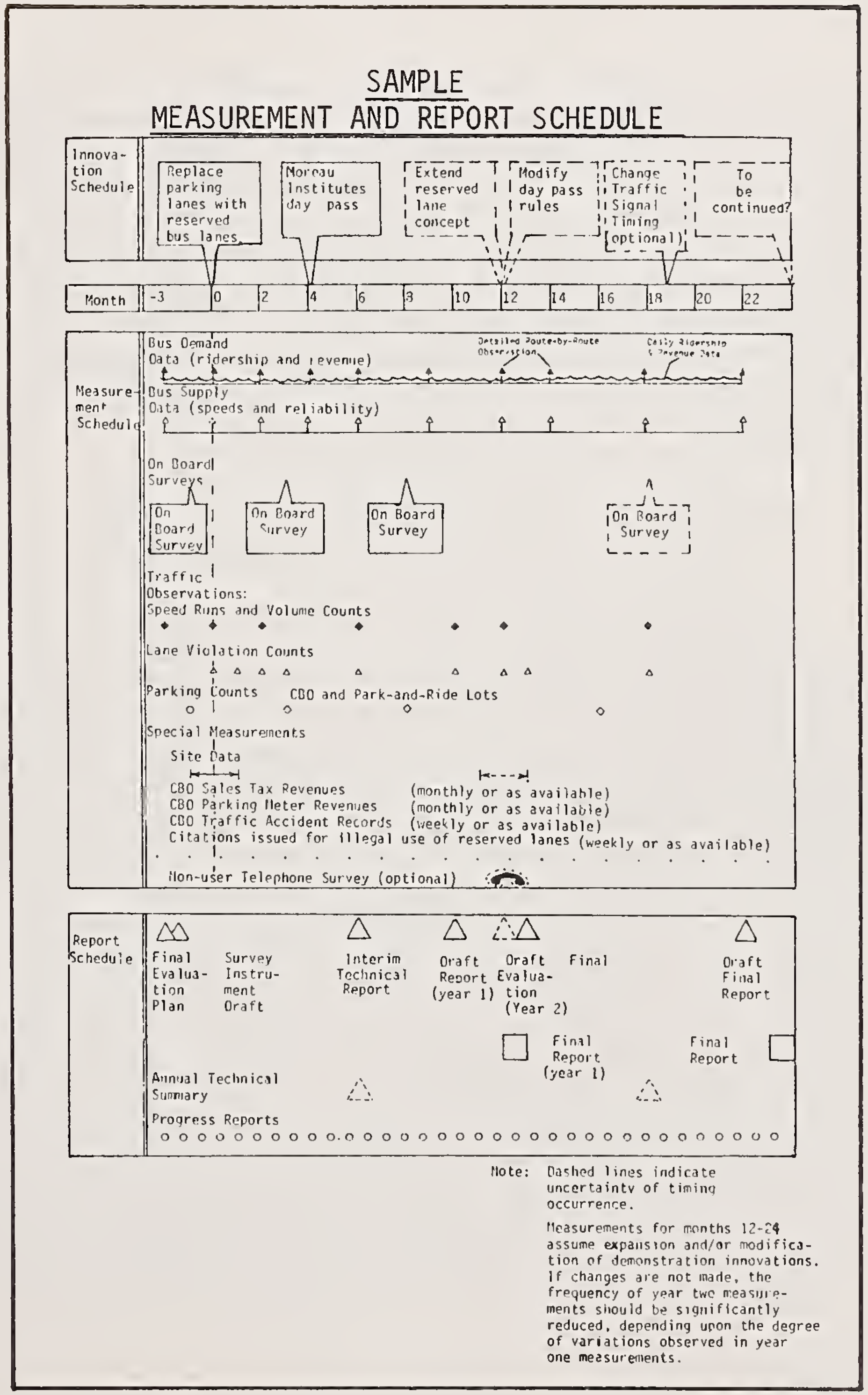
(2) Available proxy variables may be used in place of missing data; and

(3) Data may be estimated by induction or deduction from existing data by using explicit models (a technique often used to calculate pollutants from vehicle-miles traveled).

6.2.15 Scheduling Evaluation Activities

It is important that a schedule of evaluation activities be developed and coordinated with the project implementation and operation schedule. The evaluation schedule should show the anticipated timing of measurements, analysis, and reporting relative to the timing of project activities. A sample evaluation schedule is shown at the right.

A working version of the evaluation schedule should be completed prior to the implementation stage to ensure that data will be collected in a timely fashion and that no perishable pre-project data will be lost. By carefully scheduling observations around the introduction of separate innovations (e.g., a fare increase and a service extension), it is often possible to document the separate impacts of these innovations. Furthermore, the development of a comprehensive schedule of measurement activities enables the evaluator to make maximum use of regularly-scheduled observations and accommodate seasonal fluctuations by collecting data during comparable time periods.



(Source: SYSTAN)

6.2.16 Publishing the Evaluation Plan

It is important that the evaluation plan be committed to writing and published between the time the project plan is adopted and the implementation phase begins. The evaluation tableaus should be used in structuring the plan, which should contain all the elements of the experimental design, including discussions of project objectives, hypothesized impacts, measurement plans, proposed analysis, data collection procedures, and a schedule of evaluation activities. A sample table of contents is shown at the right. Early publication of the evaluation plan helps to reduce the risk that perishable data will go uncollected during the implementation phase.

(A) Treatment of Frustrating Delays, Acts of God, and Other Threats to the Sanity of the Evaluator

Any transportation system evaluation will be marked by a number of exogenous events which threaten the statistical validity of the evaluation and the sanity of the evaluator. The treatment of potential threats to statistical validity (e.g., gasoline shortages which cause increased ridership, street closings which force schedule changes) are addressed in Section 6.2.12. However, many exogenous events that pose no threat to statistical validity may threaten the orderly completion of the evaluation process. In the case of a new paratransit system, such threats might include protracted union negotiations, unforeseen holdups in the funding process, delays in equipment delivery, or opposition on the part of taxi drivers who feel threatened by the prospect of competition. The best defense against such frustrations is to develop a flexible experimental design plan and update it continually to reflect changing conditions. Contingency planning is as necessary in conducting successful evaluations as in running a successful paratransit system. It is prudent to publish evaluation plans in a loose-leaf format to make it easier to accommodate the changes that are almost certain to occur.

6.2.12
Threats to Validity

CONTENTS OF THE EVALUATION PLAN

- ☐ INTRODUCTION
  - Background
  - Participants
- ☐ PROJECT DESCRIPTION
- ☐ SETTING DESCRIPTION
- ☐ OBJECTIVES AND KEY ISSUES
- ☐ EXPERIMENTAL DESIGN
  - Strategy
  - Tableaus
- ☐ DATA COLLECTION PLAN
- ☐ DATA ANALYSIS PLAN
- ☐ TREATMENT OF THREATS TO VALIDITY
- ☐ TRANSFERABILITY CONSIDERATIONS
- ☐ EVALUATION SCHEDULE

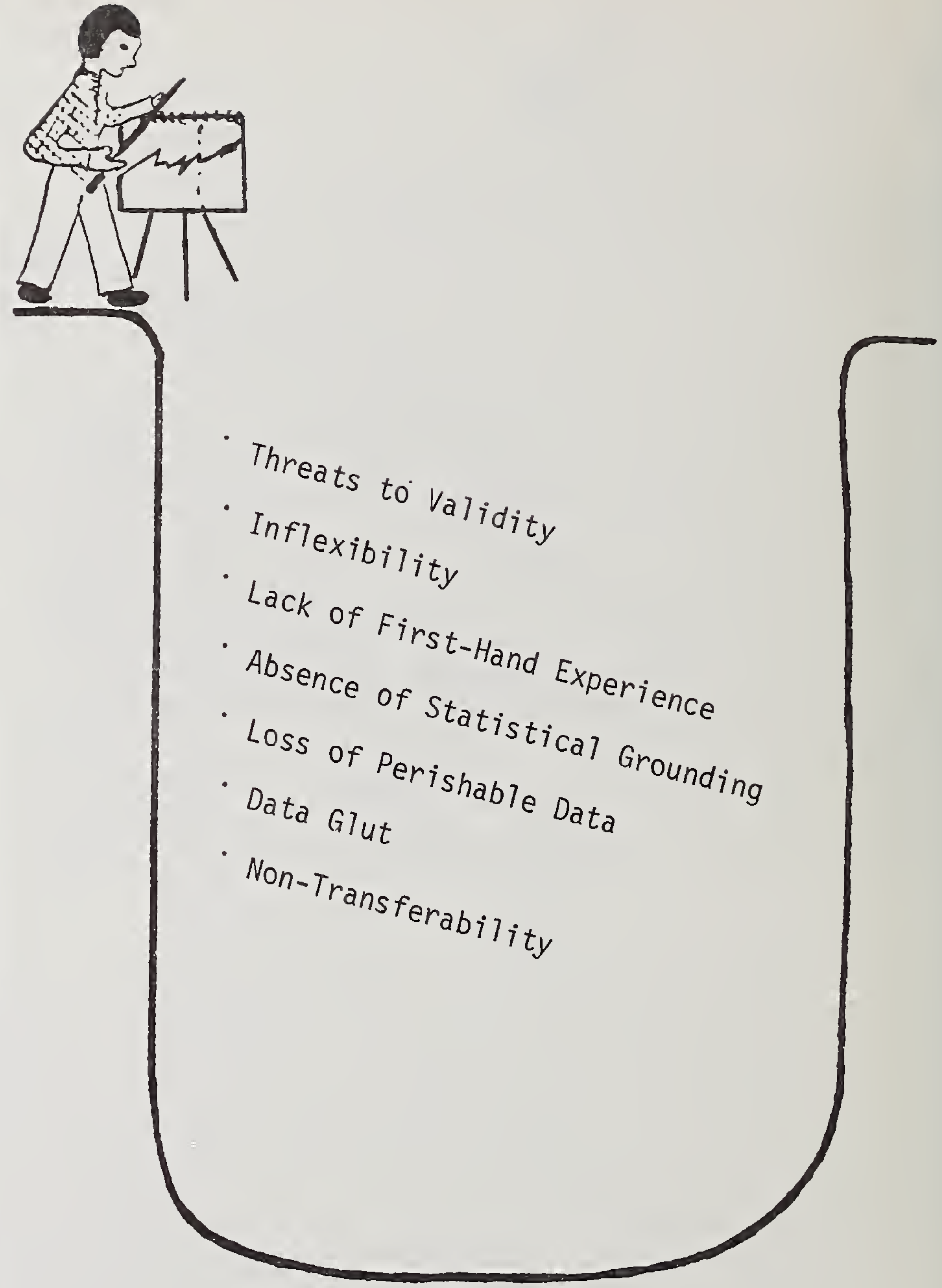
(Source: SYSTAN)

(B) Updating the Plan

During the project, the evaluation plan should be periodically reviewed to determine if additional issues have surfaced that require evaluation treatment or whether data collection plans should be altered. Often, preliminary data can be analyzed and a better estimate of required sample sizes can be made based on the data's mean and variance. In addition to reviewing the evaluation plan, those responsible for evaluation should monitor the project in order to assure that project innovations are evaluated comprehensively. Where possible, the evaluators should caution against the simultaneous implementation of service changes and other project actions which would make the interpretation of project data more difficult. In all cases, the evaluation must be subservient to project concerns. In many cases in which project objectives and evaluation objectives appear to conflict, however, compromises may be worked out which threaten neither the success of the project nor long-term evaluation benefits. One of the roles of the evaluator is to interact with the operator so as to minimize the loss of information that could accompany arbitrary changes in the state of the project.

6.3 Evaluation Pitfalls

Common evaluation pitfalls are summarized below.



THREATS TO VALIDITY

Exogenous events, transient learning periods, population changes, the timing of system improvements, instrument accuracy, seasonal fluctuations, and even the act of measurement can threaten the results of the evaluation. The evaluation plan should anticipate and counter as many of these threats as possible.

INFLEXIBILITY

Transportation system evaluators can expect to cope with frustrating delays, acts of God, and system changes in the course of any evaluation. The evaluation plan should be flexible enough to cope with these frustrations, and should be continually updated to reflect changing conditions.

LACK OF FIRST-HAND EXPERIENCE

Evaluators should monitor each phase of the data collection process, and should observe the collection of field data first-hand to make sure that proper procedures are followed and that the analyst can relate the statistics on paper to bus movements on roads.

ABSENCE OF STATISTICAL GROUNDING

Too many transportation evaluations ignore the need for statistical precision in data collection and reporting. Sample sizes should be calculated in advance, and confidence limits should be provided with all measurements so the reader can assess the statistical significance of reported findings.

LOSS OF PERISHABLE DATA

The evaluation plan must be completed in time to permit a documentation of system conditions prior to service initiation.

DATA GLUT

Data can be costly to obtain, and care should be taken to collect no more than are necessary for the purpose at hand. Continual monitoring of data variability will help to highlight instances in which sample sizes can be cut. A surfeit of data can also be difficult to analyze and explain.

NON-TRANSFERABILITY

Care should be taken to document any unique features of the locale and operating system, and to define evaluation variables in universal terms, so that other jurisdictions may interpret and apply evaluation findings.

PART 3 SYSTEM CHARACTERISTICS

1.0 INTRODUCTION

The purpose of this part of the Handbook is to provide a detailed documentation of U.S. paratransit systems. First, the measures used to evaluate system performance will be defined and, second, various characteristics of the two general categories of paratransit service -- general market and target market -- will be reviewed. The information presented in Section 3 is meant to supplement the discussion of PDIOE considerations in Part II (Creating the System). Section 4, on target market systems, offers information and guidance specifically tailored to the planning of systems to be reserved for such special target groups as the elderly and handicapped.

The information on individual existing systems is offered as an aid to estimating the performance of prospective systems during the completion of the planning and design processes, and to give the reader a wider perspective of paratransit for policymaking and research purposes. The following examples of how this information can be used in the decisionmaking process should explain the importance of this information.

One use of the information to be presented in Part III is to temper the exuberance and enthusiasm of staff or consultants who become advocates for new concepts they are studying. When a feasibility study projects dial-a-bus productivities of nine passengers per vehicle-hour, while data on existing systems indicates that only five percent of all existing systems reach such high productivities, the decisionmaker should ask, "Why do we think we can do better than everyone else?" The staff preparing the feasibility study may be able to explain why higher productivities are expected, and they should be challenged to do so. While a productivity of ten passengers per vehicle-hour may seem reasonable to anyone familiar with fixed-route bus productivities, paratransit productivities have historically been considerably lower. The decisionmaker armed with knowledge of other paratransit operations is better prepared to question the technical
assumptions used in the planning process. 1.0

Aggregate statistics on existing paratransit systems indicate what a decisionmaker is likely to encounter in his own area in terms of demand, service levels, and costs. In addition to reviewing aggregate statistics, the decisionmaker will find it useful to identify one or more existing systems which closely resemble the prospective system in configuration, area, and population served. By examining similar systems in similar settings, the decisionmakers will be better able to evaluate estimates for their own areas. Although no two communities are alike, and the experience of one community may not give the level of confidence needed for detailed system design, information on existing operations can be extremely useful during the preliminary planning process.

Attempts to use experiences in one or more service areas as a guide to what is likely to happen in another service area are subject to several shortcomings. Since no two service areas are identical, performance data should always be used in combination with area-specific socioeconomic, demographic, and geographic data to ensure that important interarea differences will be taken into account when projections are made. Nevertheless, subtle differences between service areas may lead to substantial differences in eventual system performance. Problems encountered in using past data to predict future system performance will be reduced over time as ongoing research singles out important factors included in the process of assessing comparability. Some of this research has been accomplished, but it has not yet been adequately refined and applied to provide reliable estimation models.

Data are not available on all of the 308 paratransit systems identified. The characteristics described in this section are based on 119 systems for which relatively complete data were sent in response to requests for information. The composition of this sample is shown in the accompanying exhibit.

1.0

A detailed description of these 119 systems can be found in the system summary sheets in Appendix A-4.

Services were grouped into two major classifications (general market and target market) and three subclassifications (dial-a-bus, shared-ride taxi, and integrated services). (Mixed systems or combinations of dial-a-bus and shared-ride taxi, are not considered separately, since their characteristics can be inferred from their components.) These classifications were chosen because they represent the major options available to public officials, policymakers, and planners. Moreover, the operating performance of these systems is different. Data revealing the similarities and differences between these system options will aid these officials, policymakers, and planners early in the decisionmaking process.

With the exception of the integrated system and target market shared-ride taxi subclassifications, sufficient responses were received in each of the major classifications and subclassifications to provide an accurate picture of representative systems. Integrated systems are currently operating in Ann Arbor, Rochester, and Westport, but they do not provide sufficient data to support conclusions regarding integrated paratransit operations. Using selected statistics, overviews of four types of service are presented on the following pages:

- General Market - Dial-A-Bus (DAB);
- General Market - Shared-Ride Taxi (SRT);
- Target Market - DAB; and
- Target Market - SRT.

The Canadian systems have been separated from the U.S. systems because they are significantly different in the type of service offered and performance statistics (see statistics on the second general market exhibit, which follows).

SAMPLE SIZES USED TO DEVELOP SYSTEM STATISTICS

	Sample Size	
System Type	U.S. Systems	Canadian Systems
General Market-DAB	50	7
General Market-SRT	28	1
Target Market-DAB	31	-
Target Market-SRT	7	-
Integrated Systems	3	-
Total	119	8

Go to APPENDIX A-4
Individual System Descriptions

2.0 MEASURES OF SYSTEM CHARACTERISTICS AND SYSTEM PERFORMANCE

2.1 Measures Used and Their Presentation

The measures used to define the characteristics and performance of paratransit services and service areas are summarized in the tables on the following three pages for both general market and target market services. Several items of information -- such as service patterns, service area demographic data, and user profiles -- have been included in subsequent sections to characterize the setting of each service type. These tables contain three items of information for each measure: the median, the range, and the number of systems reporting. Bar charts (or histograms) displaying the number and array of systems surveyed are provided for the most significant measures. The numbers within the bar refer to the actual systems whose values are represented in the histogram, and refer the reader to the system survey sheets in Appendix 4.

It is evident from noting the range in the system characteristic values that existing paratransit services vary to a significant degree. These ranges suggest that there is a wide variety of viable paratransit systems.

The extremes of the range can be useful to planners, and are therefore often cited in the text. To provide a sense of the typical or average system, however, the median value of each variable is given. The median rather than the arithmetic mean of the variable is used because it is not sensitive to extreme values. The mean, in contrast, can be altered substantially by extreme values, and is therefore less useful as a measure of typicality.

Go to
APPENDIX A-4
for individual
system surveys

To further eliminate the effects of extreme values and to indicate what most services are like, a range of values about the median is sometimes used in the subsequent discussion of systems. This range usually includes 50% or more of the systems reporting, and is selected to allow comparison of target market to general market and of DAB to SRT services.

2.2 Data Quality

A discussion of data quality is provided in a subsequent exhibit.

2.3 Discussion of the Measures

The measures used in system analysis are discussed below. Readers who are already familiar with these terms may wish to skip this section and proceed to Section 3.

2.3.1 Service Area Characteristics

The service area characteristics of existing systems can be used to help planners examine communities similar to their own; this will aid in the prediction of impacts that paratransit may have in their particular areas. The primary measures of service area types are the size in square miles, the population, and the population density in persons per square mile. In addition, demographic information from census data (including age and income distributions, number of automobiles, transport modes used, etc.) provides useful comparison values.

GENERAL MARKET

	DAB			SRT			ALL		
	Median	Range	No. of Systems	Median	Range	No. of Systems	Median	Range	No. of Systems
POPULATION (in 1000s)	18.0	2.1-244	50	34.2	10.5-315	28	25.0	2.1-315	78
SERVICE AREA (sq. miles)	7.6	1.6-3372	50	11.4	4-151	28	9.6	1.6-3372	78
POPULATION DENSITY (pop/sq mi)	2059	10-18733	50	4110	838-13478	28	2462	10-18733	78
FLEET SIZE (vehicles)	4.6	1-18	50	5.8	1-75	28	5.0	1-75	78
SERVICE HOURS/DAY	11.9	6-24	45	12.0	7-24	26	12.0	6-24	71
FARES (in dollars)	.50	0-2.00	40	.50	.15-1.00	21	.50	0-2.00	61
ANNUAL VEH. HOURS (1000s)	8.8	1.6-63.3	38	11.9	2.1-44.4	22	10.6	1.6-63.3	60
ANNUAL VEH. MILES (1000s)	145.0	18-841	37	153.8	26-792	17	152.2	18-841	54
WEEKDAY RIDERSHIP	206	14-1000	50	260	20-3200	28	220	14-3200	78
PERSON TRIPS/1000 POP./DAY	9.8	.81-65.2	50	4.3	.98-27.6	28	8.4	.81-65.2	78
PERSON TRIPS/SQ MI/HOUR	2.4	.005-16.7	45	1.40	.19-5.0	26	1.76	.005-16.7	71
TRIP LENGTH (miles)	1.85	.5-9.5	12	2.55	.8-3.7	12	2.25	.5-9.5	24
RIDE TIME (minutes)	14.8	7-30	23	10.2	1-20	11	13.2	1-30	34
ACTUAL WAIT TIME (mins)	15.0	5-37	21	15.0	2-27	16	15.0	2-37	37
PASSENGERS/VEH. HR	5.86	1.8-11.0	38	5.49	2.8-8.7	22	5.76	1.7-10.7	60
PASSENGERS/VEH. MI	.46	.08-.94	37	.46	.22-.74	17	.46	.08-.94	54
COST/PASSENGER ($)	1.82	.85-4.47	35	1.70	1.05-2.94	11	1.78	.85-4.47	46
REVENUES/PASSENGER ($)	.29	.21-.59	10	.45	.37-.92	6	.37	.21-.92	16
COST/VEH. HR ($)	10.00	5.14-22.04	31	9.95	8.97-14.65	11	9.96	5.14-22.04	42
DRIVERS WAGE ($)	4.00	3-5.67	13	3.35	2.80-4.00	10	3.53	2.80-5.67	23
DRIVERS FRINGE BEN. (%)	24	15-40	7	22.5	20-24	4	23.2	15-40	11
NO. OF EMPLOYEES	8.8	1-29	27	8.2	5-165	8	8.6	1-165	35

(Source: SYSTAN)

GENERAL MARKET

	INTEGRATED SYSTEMS						CANADIAN DAB		
	Median	Range	No. of Systems				Median	Range	No. of Systems
POPULATION (in 1000s)	105	30-180	3				20.8	10.9-63.0	7
SERVICE AREA (sq. miles)	22.8	22.2-45.0	3				6	3.0-12.0	7
POPULATION DENSITY (pop. sq. mile)	4000	1351-4605	3				3043	1815-7000	7
FLEET SIZE (vehicles)	26	11-48	3				8	3-26	7
SERVICE HOURS/DAY	15.8	8-19.2	3				18	11-19	5
FARES (in dollars)	1.25	.35-3.00	3				.45	.40-.55	7
ANNUAL VEH. HOURS (1000s)	29.5	22.6-104.0	3				17.2	14.4-67.2	5
ANNUAL VEH. MILES (1000s)	—	250-412	2				171.6	93.6-672	5
WEEKDAY RIDERSHIP	460	400-2500	3				1100	457-2800	7
PERSON TRIPS/1000 POP./DAY	13.3	4.4-13.9	3				63.4	22.5-73.3	7
PERSON TRIPS/SQ. MI./HOUR	2.5	1-3.5	3				9.3	4.5-24.6	5
TRIP LENGTH (miles)	2.6	2.3-3.7	3				4.2	3.3-5.0	4
RIDE TIME (minutes)	12.2	11-15	3				14	12-17	5
ACTUAL WAIT TIME (minutes)	17.0	6.4-20.0	3				12	10-25	5
PASSENGERS/VEH. HOUR	5.1	3.4-5.6	3				9.6	9.0-12.1	5
PASSENGERS/VEH. MILE	—	.24-.46	2				1.08	.77-1.39	5
COST/PASSENGER ($)	—	3.54-4.22	2				—	1.31-2.82	2
REVENUES/PASSENGER ($)	.55	.23-1.40	3				—	.39-.41	2
COST/VEH. HOUR ($)	—	19.85-21.46	2				27.10	—	1
DRIVERS WAGE ($)	5.15	4.00-6.61	3				6.87	—	1
DRIVERS FRINGE BEN. (%)	20	—	1				36	—	1
NO. OF EMPLOYEES	—	26-28	2				10	—	1

(Source: SYSTAN)

2.1

TARGET MARKET

	DAB			SRT			ALL		
	Median	Range	No. of Systems	Median	Range	No. of Systems	Median	Range	No. of Systems
POPULATION (in 1000s)	159.0	6.0-3367	28	59.9	20-121	7	130.0	6.0-3367	35
ELIGIBLE POPULATION (1000s)	15.4	.075-220	20	3.0	2.2-7.0	3	14.9	.075-220	23
SERVICE AREA (sq. miles)	106.0	.8-5700	29	22.0	3-94	7	88.4	.8-5700	36
ELIGIBLE POP/SQ. MI.	150	2-953	18	200	88-320	3	160	2-953	21
FLEET SIZE (vehicles)	5.2	1-50	29	4.0	1-32	7	5.1	1-50	36
SERVICE HRS/DAY	10.8	6-18	28	9.2	8-12	5	10.6	6-18	33
FARES (in dollars)	.005	0-1.00	24	.50	.25-.50	4	.25	0-1.00	28
ANNUAL VEH. HRS. (1000s)	10.9	1.2-278	17	8.3	2.0-45.2	3	9.2	1.2-278	20
ANNUAL VEH. MILES (1000s)	176.4	21.6-3480	22	47.0	39.9-149	4	110.3	21.6-3480	26
WEEKDAY RIDERSHIP	132	7-1480	29	50.0	14-285	7	80.5	7-1480	36
PERSON TRIPS/1000 Eligible Population/DAY	8.0	.9-1467	18	26.7	10.3-405	3	9.9	.9-1467	21
PERSON TRIPS/SQ.MI./HR	.15	.001-2.4	26	.83	.01-5.7	5	.18	.001-5.7	31
TRIP LENGTH (miles)	4.45	.8-150	18	2.0	.5-3.8	6	4.0	.5-150	24
RIDE TIME (minutes)	20.2	3-90	14	15.5	15-20	2	20.0	3-90	16
ACTUAL WAIT TIME (minutes)	20.2	5-35	7	25.5	15-45	4	25.0	5-45	11
PASSENGERS/VEH. HR.	3.0	1.0-16.2	17	6.7	1.9-6.8	3	3.0	1.0-16.2	20
PASSENGERS/VEH. MI.	.22	.03-3.13	22	.54	.34-.75	4	.28	.03-3.13	26
COST/PASSENGER ($)	4.05	.34-10.72	13	2.11	–	1	3.89	.34-10.72	14
REVENUES/PASSENGER ($)	.37	.08-2.10	8	.50	–	1	.44	.08-2.10	9
COST/VEH. HR. ($)	13.23	6.92-20.26	11	14.16	–	1	13.23	6.92-20.26	12
DRIVERS WAGE ($)	3.70	2.65-6.08	17	3.30	–	1	3.62	2.65-6.08	18
DRIVERS FRINGE BEN. (%)	18	9-30	12	–	–	–	18	9-30	12
NO. OF EMPLOYEES	9.5	1-181	20	20	–	1	9.6	1-181	21

(Source: SYSTAN)

QUALITY OF OPERATING CHARACTERISTICS DATA

The data are not uniformly completed for all data elements. Those elements based on fewer responses should be considered to be less reliable than those based on larger samples.

Since not all systems responded with complete data, a non-respondent bias may exist in the data (i.e., those not responding may be dissimilar to those responding).

The data collected were supplied by the systems themselves; therefore, their validity depends on the respondent's interpretation of data element definitions. In addition, the accuracy of the responses may vary from respondent to respondent; obvious errors were followed up with the respondent and corrected.

As noted on the systems characteristics sheets, the data from different systems may be from different time periods (within a two- or three-year span). Prior to detailed analysis, adjustments should be made on the basis of the price index.

Because the median values reported are based on different sample sizes, and because of the nature of medians, operations on two or more median values (ratios, etc.) will not yield valid population statistics.

The data are deemed sufficiently complete and valid to provide a picture of the current state of paratransit operations and to guide decisionmakers in areas considering paratransit systems.

Researchers should be aware of the data limitations when performing statistical analysis and modeling.

2.3.2 Supply Measures

Characteristics that define the type and extent of service are referred to as supply measures. Supply is defined qualitatively by descriptions of service patterns, including route or schedule constraints (many-to-many, many-to-few, many-to-one, deviation from route, deviation from checkpoint), prescribed timing of service requests (immediate or subscription), and method of access (phone, hail, fixed stops). Other, more quantitative measures of supply include the number of vehicles in the fleet, the number of hours per day that the service is offered, and the level and type of fares.

2.3.3 Demand

Demand is defined by the level of ridership and descriptions of users. Weekday ridership is an aggregate measure of demand, but it is not a useful value for comparison since it does not consider the size of the system. The more useful measures of ridership, which eliminate size variability, are person-trips per day per 1,000 service area residents and person-trips per square mile of service area per hour. Both these measures should aid planners in estimating demand for new services through comparison with existing system data and experience. The demographic characteristics of users and the types of trips they take are also useful for planners in judging what segments of the community will use the candidate services.

2.3.4 Service Quality

The quality of service is measured from the viewpoint of the user, and pertains to the time required to use the service. Quality can be measured by ride time, wait time (for immediate or prearranged service), and the time required to transfer between paratransit services or between paratransit and fixed-route services. Total travel time relative to the time the same trip would take by automobile is a frequently used measure of quality.

2.3

This is frequently estimated by using data on trip length along with ride time to calculate transit vehicle speed, which can then be compared to generic automobile speeds.

2.3.5 Productivity and Costs

Productivities and costs of service are two related measures of paratransit performance. Productivity measures the demand (in number of passengers) carried per unit of supply (measured either by vehicle-hours or vehicle-miles). Passengers per vehicle-hour is the most commonly used productivity measure, but passengers per vehicle-mile is also included here because it is used by some systems. The relationship between the two measures and how they are affected by service area characteristics (e.g., size, population density, traffic conditions), demand characteristics (e.g., demand density, trip length), and patterns and combinations of paratransit have not been researched sufficiently to provide guidance for planners or operators in evaluating what can be expected of their service. When using these data for planning, these other factors should be included by searching for areas with services comparable to those being planned.

The cost of service is measured in dollars per vehicle-hour or per vehicle-mile. These are pure supply measures unrelated to demand, and will vary according to the equipment used, the organizational structure, and the prevailing labor wage rates.

A useful measure for planning and evaluation purposes which combines cost and productivity is cost per passenger, which is also used in calculating the revenue recovery (the percentage of costs paid by revenues). Revenue recovery is a particularly sensitive measure for political decisionmakers.

Productivity and cost figures are often used to compare paratransit to fixed-route services. When done in individual areas, this comparison is useful; when performed on aggregate industry figures, the comparison may be misleading. Section 3.1.5 discusses these comparisons.

3.1.5
Is It Cost-Effective?

3.0 GENERAL MARKET SYSTEMS

3.1 Operational Data

3.1.1 Service Area Characteristics

DAB systems serving general markets typically:

- Serve small cities;
- Serve an entire city; and
- Provide the only transit in town.

SRT systems serving general markets typically:

- Serve small cities;
- Serve an entire city; and
- Feed local fixed-route buses.

(A) Service Area Size

The DAB service areas surveyed are small relative to those of fixed-route systems, having a median size of 7.6 miles. About sixty percent of these systems operate in service areas of between four and sixteen square miles. The range of area size is large, however, extending from Davison, Michigan (with a service area of 1.6 square miles) to East Upper Peninsula, Michigan (which serves an area of 3,372 square miles). The Michigan Upper Peninsula, a rural and sparsely-populated area, is somewhat atypical of most DAB systems.

SRT general market systems serve the entire area of small cities, but occur in more densely-populated areas than do DAB systems and typically coexist with and feed fixed-route systems. They serve areas slightly larger

GENERAL MARKET PARATRANSIT SETTINGS

	Percent of Systems*	
	% DAB	% SRT
Type of Setting	No=44	No=19
Large Urbanized Area	---	5.3
Small Urbanized Area	15.9	26.3
Small City	61.4	63.2
Rural	22.7	5.3
	100.0	100.0
Service Area Scope	No=34	No=21
Entire City	50.0	71.4
Section of City	23.5	19.0
Urban Area	11.8	9.5
Suburban Area	14.7	23.8
Entire County	11.8	4.8
Rural	17.6	---
	129.4	128.5
Modes Integrated with Paratransit	No=26	No=14
Local Fixed-Route Bus	34.6	50.0
Intercity Fixed-Route Bus	3.8	14.3
DRT in Other Zones	15.4	21.4
No Other Service	57.7	35.7
Rail	7.7	7.1
Other	11.5	35.7
	130.7	164.2

*Adjusted Frequency (%)

Totals higher than 100% due to multiple responses.

(Source: SYSTAN)

than DAB systems do although, as shown in the bar chart, about seventy percent of these services are between four and sixteen square miles, a statistic comparable to DAB service. SRT service areas range from four square miles in Colton, California and St. Bernard Parish, Louisiana to 150.8 square miles in Little Rock, Arkansas.

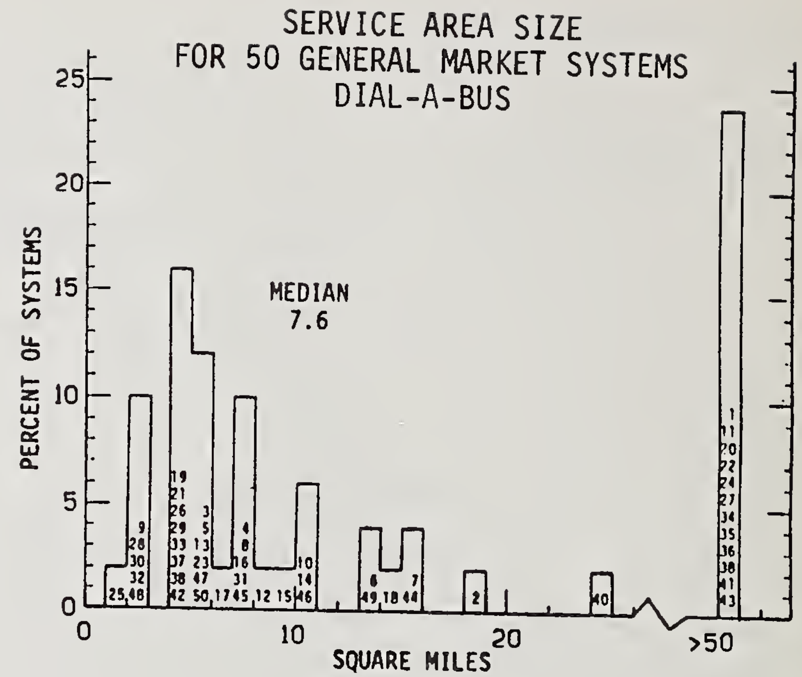
(B) Service Area Population

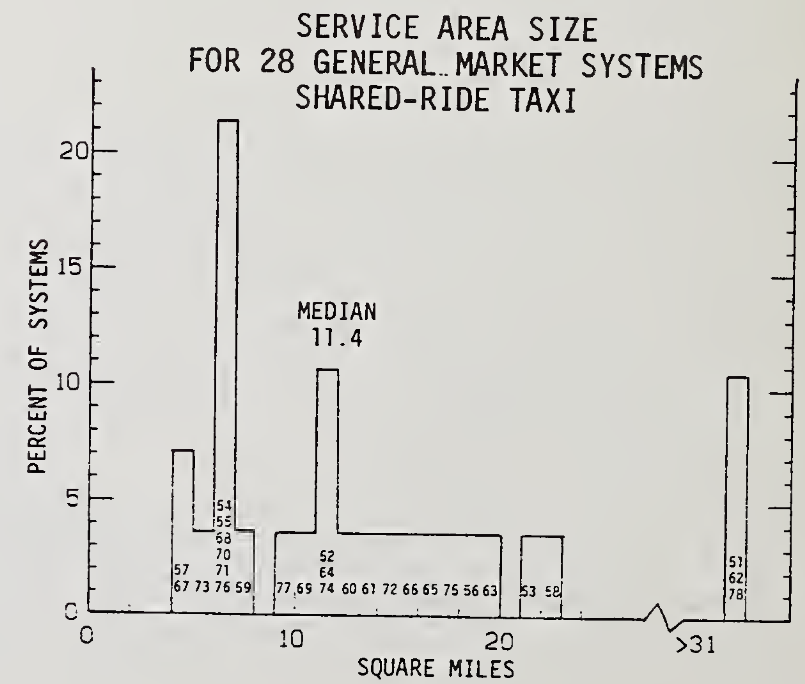
Populations served by general market DAB services range from 2,000 in Gladwin, Michigan to 243,000 in the Hollywood-Westlake-East Wilshire area of Los Angeles. The median service area population is 18,000 and just over seventy percent of the systems operate in areas of 5,000 to 35,000 persons (see histogram).

SRT general market systems serve median populations of 34,000, about twice as large as DAB systems. Populations served range from 10,500 persons in Cadillac, Michigan to 315,000 in Little Rock, Arkansas. Service areas with populations between 10,000 and 65,000 account for seventy percent of the SRT systems responding (see histogram).

(C) Service Area Population Density

Population density (persons per square mile of service area) is a useful statistic for evaluating different service areas during the planning stage. The median density for DAB general market services is just over 2,000 persons per square mile, ranging from 10 in East Upper Peninsula, Michigan to 18,700 in the Hollywood-Westlake-Wilshire area of Los Angeles. As shown in the accompanying histogram, over three-quarters of the services operate in areas having population densities up to 4,000 persons per square mile.





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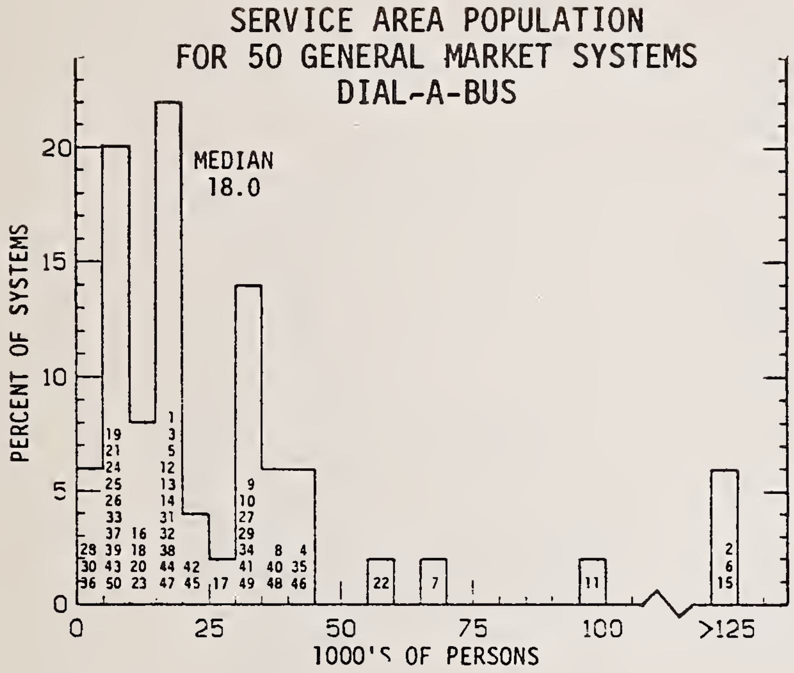

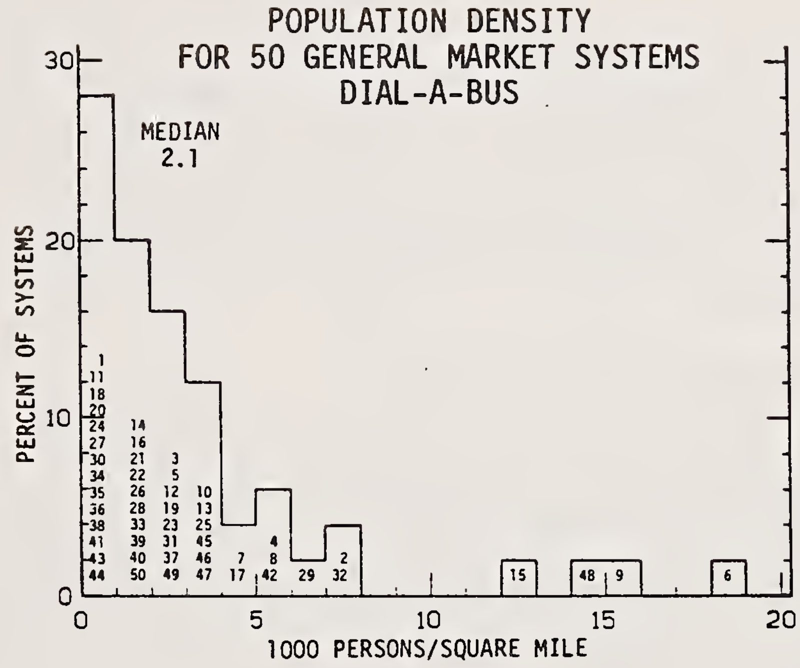

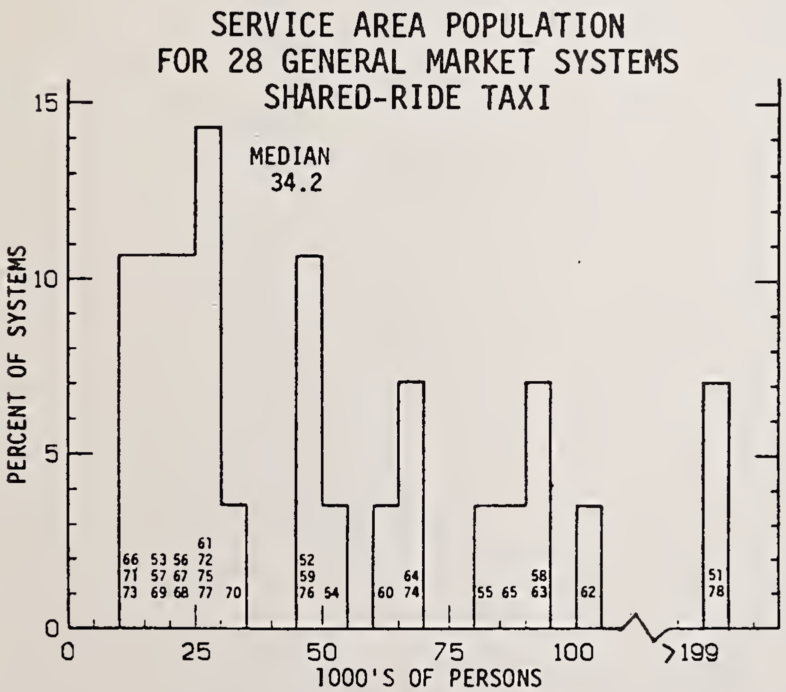

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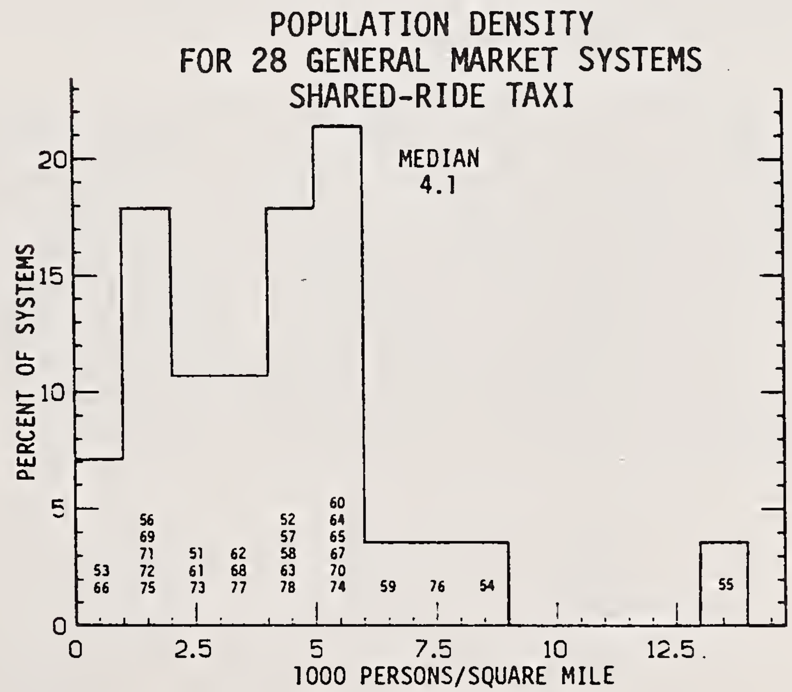

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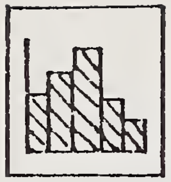


3.1.1

SRT systems serve areas having a median population density of over 4,100 persons per square mile, or over twice the density of areas served by DAB systems. Only forty-eight percent of the SRT systems surveyed serve areas with densities up to 4,000 persons per square mile (see histogram), compared to seventy-five percent for DAB systems. The density figures range from 838 in Victorville, California to 13,400 in Beverly-Fairfax (Los Angeles).

(D) Demographic Characteristics

The demographic characteristics of six general market DAB service areas are shown in the next exhibit. These areas, chosen because the data were readily available, demonstrate the wide variety in the demographics of the communities served by general market DAB systems; of particular interest are the percentages for population over age 64, the use of transit for work trips, and income distribution. The demographic characteristics of six SRT areas in the next exhibit show the equally-disparate characteristics of SRT systems.

SRT systems generally serve larger, more densely-populated urban areas than do DAB systems. This may be attributed to the existence of extensive taxi operations when shared-ride systems were considered. Taxis provide an established resource which can easily be modified for shared-ride service. SRT service may also provide better service in higher-density urban areas, due to the greater mobility of taxis in comparison to buses. This would not hold true in areas of high demand density, as the limited capacity of taxis would constrain service efficiency.

DEMOGRAPHIC CHARACTERISTICS OF SELECTED DAB SERVICE AREAS

	Ann Arbor Michigan (test area)	Haddonfield New Jersey	La Mirada California	Rochester New York	United States Averages
Population Age Groups (%)					
Under 5	8.0	7.3	7.0	8.8	8.4
5 - 19	23.5	30.7	38.7	27.9	-
20 - 64	60.6	53.2	51.6	55.3	-
Over 64	7.9	8.6	2.7	7.9	9.9
Total Population	14,065	39,882	30,808	55,364	-
Non-College School Enrollment	3,129	11,131	12,981	14,039	-
Number of Workers	6,668	15,338	12,137	23,588	-
Means of Transportation to Work (%)					
Auto Driver	73.3	68.6	84.8	71.0	66.0
Auto Passenger	12.7	9.4	7.0	14.7	11.7
Bus or Street Car	1.5	3.2	0.2	7.1	5.5
Subway: Elevated Train or RR	0.1	10.3	-	0.0	2.3
Walk	8.0	3.7	4.8	5.0	7.4
Worked at Home	1.5	1.6	1.3	1.0	3.5
Other	2.9	3.1	1.8	1.2	3.6
Employment					
Total Civilian Labor Force	6,973	15,878	13,024	24,662	-
Unemployment Percentage	2.9	2.2	4.8	2.2	4.9
Income Groups (%)					
Under $4,000	6.3	21.6	4.1	5.6	14.0
$4,000 - 10,000	21.8	21.6	17.9	20.4	37.0
$10,000 - 15,000	27.5	28.7	36.2	39.2	26.8
$15,000 - 25,000	34.7	30.8	35.3	31.0	17.7
Over $25,000	9.6	14.0	6.5	3.8	4.6
Mean Income $(000)	13.2	15.0	13.9	13.2	9.6*
Automobiles Available					
0	7.0	7.2	1.8	7.1	18.6
1	52.0	43.4	24.2	60.4	51.4
2	33.7	42.4	56.8	28.6	24.3
2+	7.3	7.0	17.3	3.8	5.7

* Median 1970

(Source: U.S. Census of Population, 1970)

DEMOGRAPHIC CHARACTERISTICS OF SELECTED SRT SERVICE AREAS

	Hicksville New York	Little Rock Arkansas	Fullerton California	El Cajon California	United States Averages
Population Age Groups (%)					
Under 5	*	7.8	7.7	8.8	8.4
5 - 19	*	26.6	30.5	29.0	-
20 - 64	*	55.2	55.2	53.4	-
Over 64	*	10.4	6.6	8.8	9.9
Total Population	48,075	192,523	85,826	52.273	-
Non-College School Enrollment	15.136	45.120	24,301	13,976	-
Number of Workers	20,041	77,386	34,339	19,027	-
Means of Transportation to Work (%)					
Auto Driver	68.3	72.2	86.0	80.0	66.0
Auto Passenger	11.2	10.7	6.2	10.1	11.7
Bus or Street Car	1.4	4.8	0.2	0.6	5.5
Subway: Elevated Train or RR	10.2	0.0	0.0	0.0	2.3
Walk	6.0	4.1	3.9	3.4	7.4
Worked at Home	1.0	5.8	1.6	2.3	3.5
Other	1.9	2.4	2.1	3.6	3.6
Employment					
Total Civilian Labor Force	31,331	80,677	37,788	20,530	-
Unemployment Percentage	1.9	3.2	12.1	13.2	4.9
Income Groups (%)					
Under $4,000	3.7	19.0	7.3	13.9	14.0
$4,000 - 10,000	15.4	39.2	25.9	30.4	37.0
$10,000 - 15,000	37.7	24.4	26.8	32.9	26.8
$15,000 - 25,000	34.8	13.2	28.7	18.4	17.7
Over $25,000	8.4	4.2	11.3	4.4	4.6
Mean Income $(000)	13.9	8.6	15.2	11.1	9.6**
Automobiles Available					
0	4.6	21.2	-	-	18.6
1	40.7	42.0	-	-	51.4
2	44.8	32.7	-	-	24.3
2+	9.9	3.5	-	-	5.7

* Reprinted figures in error

** Median 1970

(Source: U.S. Census of Population, 1970)

3.1.2 Supplying the Service

Over eighty percent of the general market DAB systems offers many-to-many service (see exhibit). The next most common service is many-to-one, followed by route deviation and then many-to-few.

Route data are divided into peak and off-peak periods, and a number of systems chose to offer different services at different times of day. This option is available to planners in cases where demand or supply considerations justify adjusting the operating hours and staff size.

The use of the three request options (immediate, subscription, and advance) are common in both DAB and SRT service, as is the mixing of several options. SRT systems are more likely to offer immediate request service than DAB systems, while advance requests are slightly more common to DAB systems. A high percentage of both system types offer subscription service.

(A) Vehicle Fleet Size

The median fleet size for DAB services is 4.6 vehicles, ranging from single-vehicle fleets to 18-vehicle fleets. About two-thirds of the systems surveyed use 1 to 5 vehicles (see exhibit). SRT systems employ slightly larger fleets than do DAB systems, with a median of 5.8 vehicles and a range of 1 to 75 vehicles. One to 5 vehicles comprise about 43% of the SRT fleet sizes. The fact that vehicle fleets for SRT services are, on the average, larger than those of DAB systems probably reflects the larger service areas and population densities being served.

(B) Service Hours

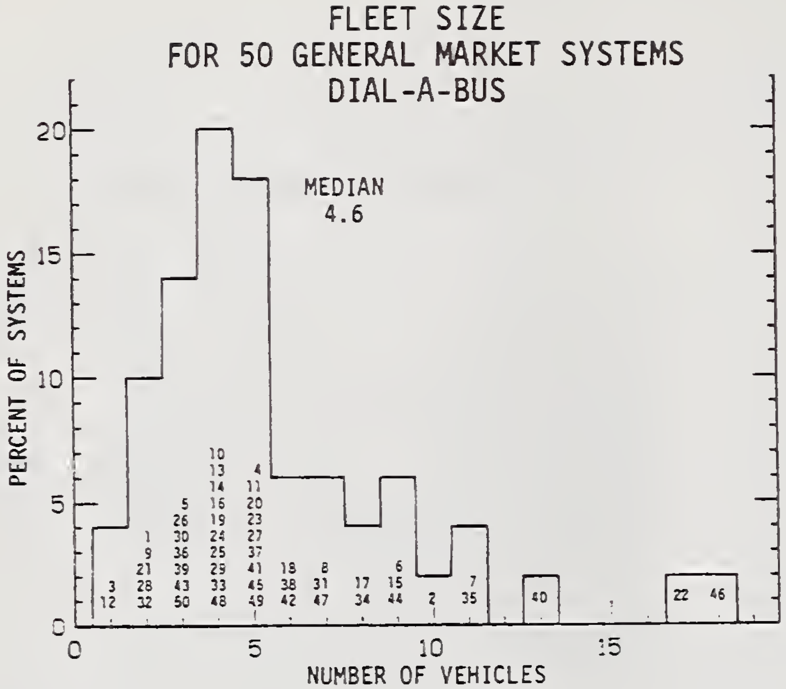
Both DAB and SRT systems offer service for a median period of about 12 hours per day. This variable ranges from 6 to 24 hours for DAB services and from 7 to 24 hours for SRT services.

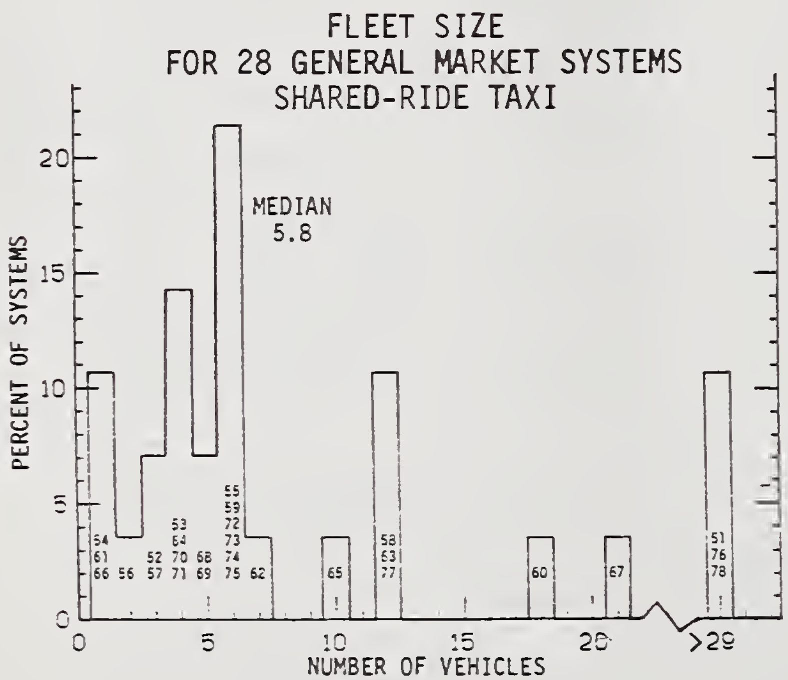
GENERAL MARKET SERVICE PATTERNS

	DAB	SRT
SYSTEMS RESPONDING	48	28
Many-to-One Peak	12.5%	3.6%
Many-to-One Off-Peak	6.3	-
Many-to-Few Peak	8.3	-
Many-to-Few Off-Peak	6.3	-
Many-to-Many Peak	72.9	96.4
Many-to-Many Off-Peak	83.3	100.0
Route Deviation Peak	10.4	-
Route Deviation Off-Peak	6.3	-
Point Deviation Peak	4.2	-
Point Deviation Off-Peak	2.1	-
Other Peak	4.2	-
Other Off-Peak	2.1	-
TOTAL	218.9%*	200.0%*
SYSTEMS RESPONDING	26	14
Immediate	65.4%	78.6%
Subscription	80.8	64.3
Advanced	57.7	50.0
TOTAL	203.9%*	192.9%*
SYSTEMS RESPONDING	26	12
Phone	100.0%	100.0%
Hail	42.3	25.0
Fixed Stops	34.6	-
Other	15.4	8.3
TOTAL	192.3%*	133.3%*

* Response higher than 100% due to multiple answers.

(Source: SYSTAN)





(Source: SYSTAN)

(C) Fares

The median fare for both DAB and SRT systems is 50 cents. This fare is charged by over half of both system types, as shown in the histogram. DAB system fares range from free to $2.00, and in SRT systems from $0.15 to $1.00.

The majority of both system types have fare structures that provide discounted rides to special groups, most often accommodating children and the elderly. The handicapped are offered special fares in just over 30 percent of general market DAB systems and just under 40% of the SRT systems. Zonal fares are used by 10% to 15% of the systems surveyed.

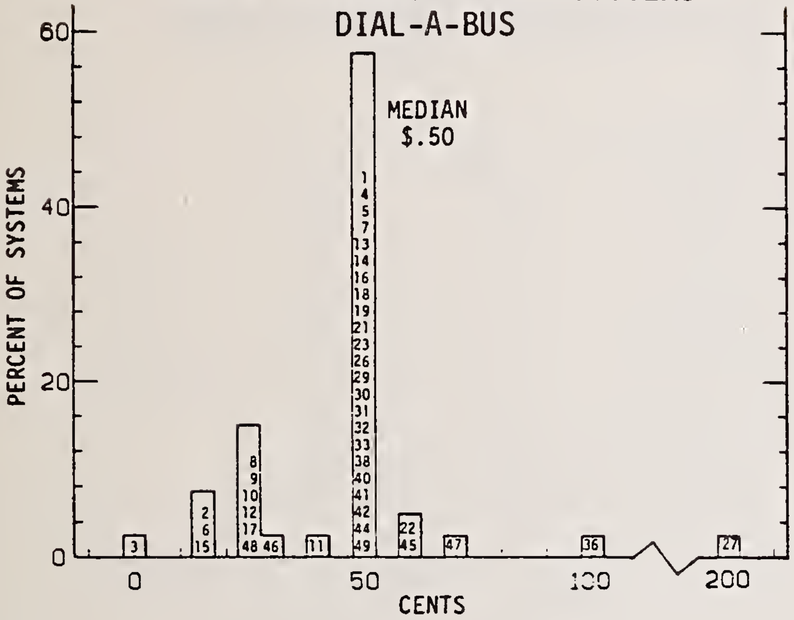
3.1.3 Demand

(A) Ridership

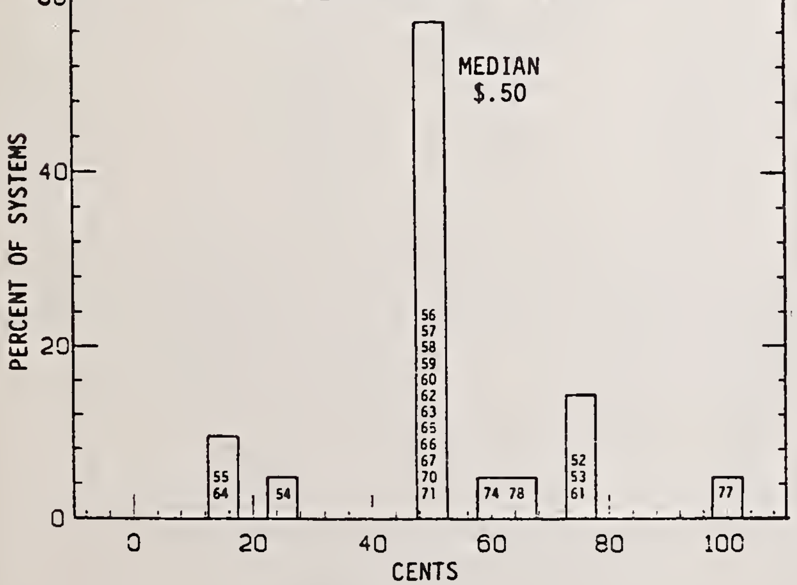
The median weekday ridership on DAB systems is slightly over 200 persons, ranging widely from 14 in Apple Valley-Hesperia, California (a discontinued system) to 1,000 in Haddonfield, New Jersey (also discontinued). The smallest weekday demand for an operating system is 50 passengers in El Segundo, California; the largest for an operating system is 500 in Columbus, Ohio. It is interesting to note for future investigation that the extremes at both the high and low demand levels are found in discontinued systems.

SRT median weekday ridership is slightly higher than that of DAB systems, at 260 passengers. The range of ridership on SRT systems is also larger than that of DAB, running from 20 in St. Bernard Parish, Louisiana to 3,200 in Little Rock, Arkansas (a private SRT system). The larger SRT ridership reflects the larger service areas of SRT systems.

BASE FARES
FOR 40 GENERAL MARKET SYSTEMS
DIAL-A-BUS



BASE FARES
FOR 21 GENERAL MARKET SYSTEMS
SHARED-RIDE TAXI



(Source: SYSTAN)

(B) Demand Density

For DAB service, the median passenger-trips per 1,000 residents per day is 9.8 and the range is from .81 in Dallas, Texas (a discontinued demonstration project) to 65 in Gladwin, Michigan. The currently-operating system with the smallest per capita density is the Hollywood-Westlake-East Wilshire system in Los Angeles, which has a density of one passenger-trip per 1,000 residents. The median for person-trips per square mile per hour is 2.4, ranging from .005 in East Upper Peninsula, Michigan to 16.7 in Columbus, Ohio. The range from zero to three includes 60% of the systems surveyed (see exhibit).

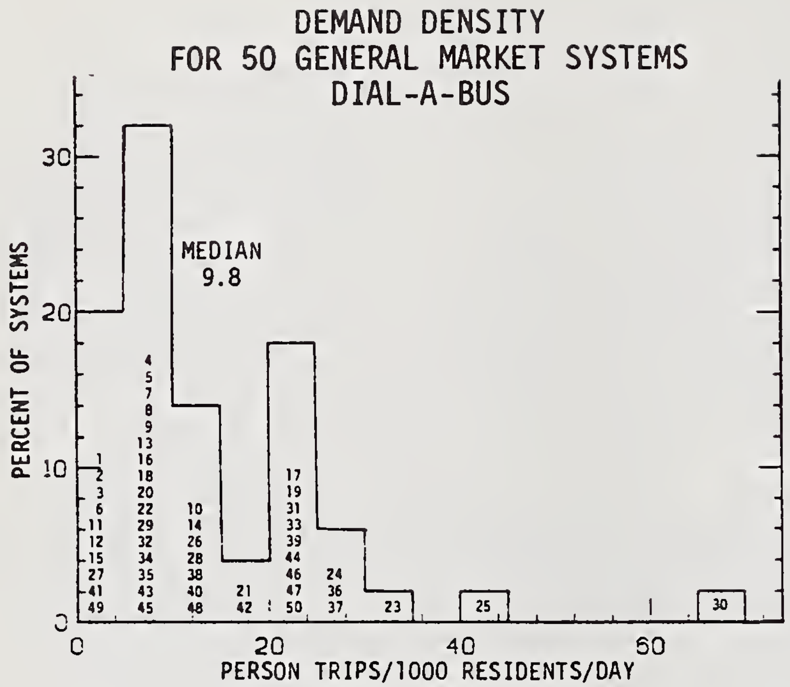
SRT systems experience a demand of 4.3 per 1,000 residents per day, less than half that of DAB systems. The full range runs from 1.0 to 27.6. The median number of person-trips per square mile per hour for SRT systems is 1.4, again about half of the comparable DAB statistic. The full range is .19 (Victorville, California) to 5.0 (Hicksville, New York), with about three-quarters of the systems falling in the range between 0 and 2.

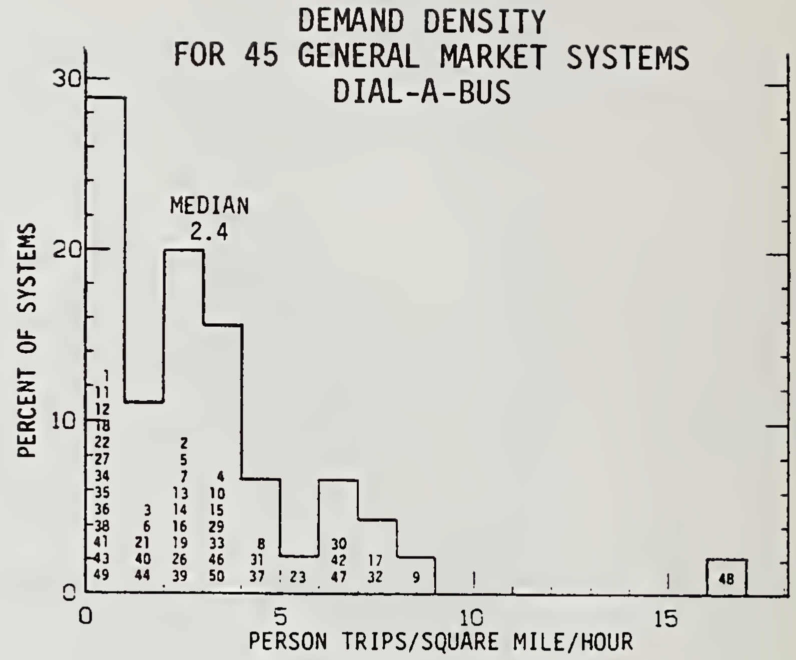
SRT systems are significantly lower in both demand density categories than DAB systems. For planning purposes, the most reasonable hypothesis is to attribute the difference to the difference in service area size--a theory to be tested in future research.

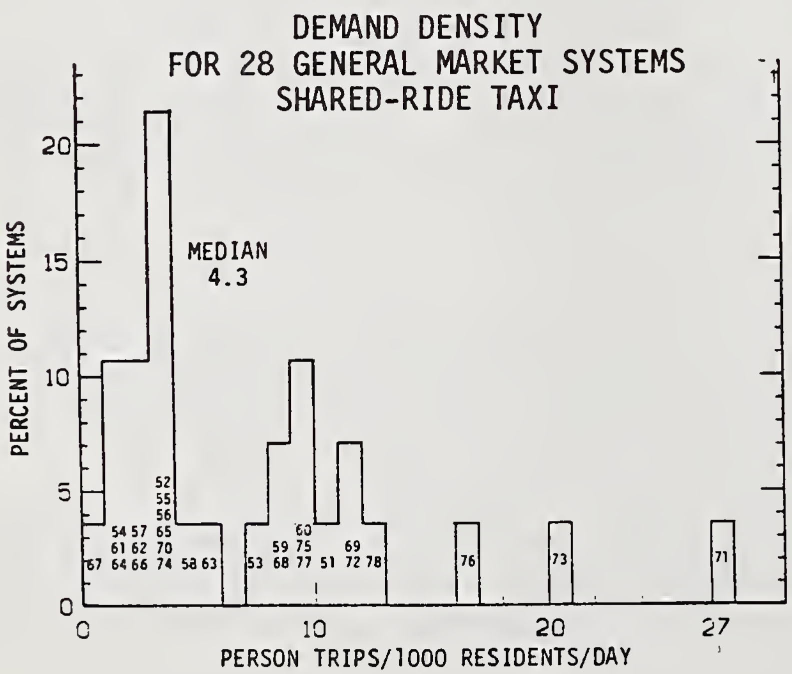
(C) Rider Characteristics

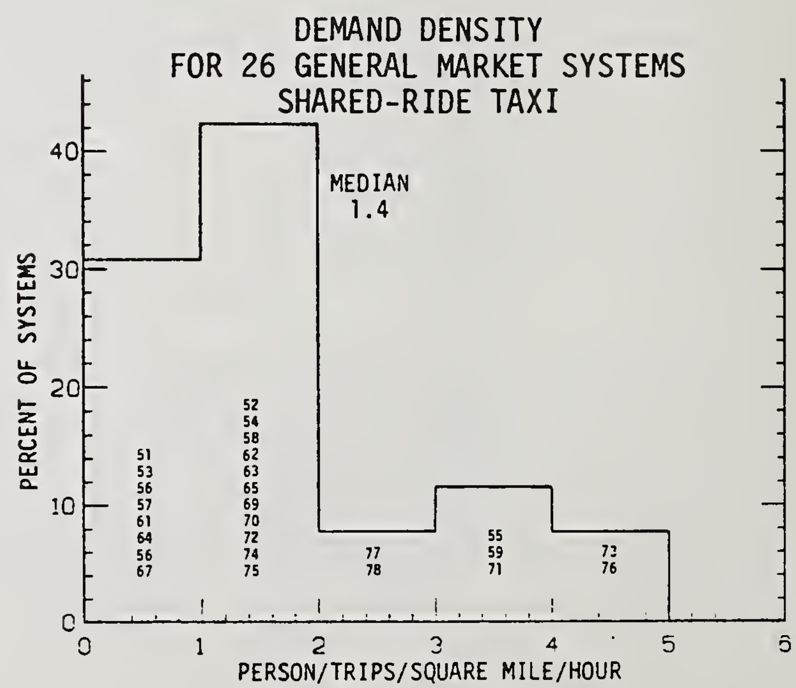
Examples of rider characteristics for four DAB systems are shown in the subsequent exhibit. Comparable data for SRT systems can be found in Gorman, Reference 94.

The tabulation of characteristics reveals that, although system users vary somewhat from system to system, a variety of riders are attracted to paratransit. As in conventional transit, female riders usually outnumber males. The journey to work is the dominant trip purpose reported by









(Source: SYSTAN)

GENERAL MARKET RIDER CHARACTERISTICS

Variable		Ann Arbor Michigan	Rochester New York	Watts-Los Angeles California	Fairfield California
Sex:	Male	48.0%	17.7%	24.4%	15.0%
	Female	52.0	82.3	75.6	85.0
Age:	Under 18	28.0	31.6	4.4	37.0
	18 - 44	41.0	32.4	55.6	27.0
	45 - 64	20.0	22.1	13.3	23.0
	65 and Over	11.0	14.0	26.7	12.0
Cars in House-Hold:	0	7.0	27.3	35.5*	36.0
	1	52.0	44.7	--	33.0
	2	41.0 (2+)	20.5	--	22.0
	3+	--	7.6	--	7.0
Purpose of Trip:					
Work		34.0	38.3	31.1	18.0
School/Soc. Serv.		23.0	6.8	14.4	4.0
Medical		--	1.2	23.3	15.0
Shopping		22.0	30.9	11.1	20.0
Recreation		8.0	9.3	20.0	20.0
Other		13.0	13.6	--	29.0
Alternate Mode:					
Bus		10.0	10.4	56.7	4.0
Walk		19.0	13.4	12.2	36.0
Taxi		13.0	10.4	5.6	27.0
Drive		19.0	4.5	--	8.0
Be Driven		31.0	29.1	18.9	13.0
No Trip		5.0	30.6	6.7	20.0
Other		3.0	1.5	--	9.0

*Figure derived from entire service area, not ridership.

(Sources: Kendall (TSC), Reference 19; Los Angeles, Reference 74; SYSTAN, Reference 82; and DAVE Systems, Fairfield DART Operations Report.)

the riders of general market systems. The data show that a substantial proportion of riders are transit-dependent. Few of the riders surveyed reported driving as an alternative choice of transportation for their paratransit trip. However, when the number of riders who reported that they would be driven if there were no paratransit service is added to the smaller number reporting driving as a feasible alternative, it is clear that the four systems surveyed diverted automobile traffic to paratransit service.

3.1.4 Service Quality

Data on service quality were available for only a relatively small number of operators. The data reported is probably based on estimates rather than precise measurements, since such measures tend to be expensive unless collected by a computer-dispatched system.

(A) Ride Time and Trip Lengths

Among the systems reporting service level data, the median ride time for DAB service was 14.8 minutes for a median trip length of 1.85 miles.

The median ride time for SRT systems was 10.2 minutes for median trip lengths of 2.5 miles. These figures imply that SRT vehicles move at a higher speed than DAB vehicles, perhaps due to the greater acceleration and maneuverability of taxis in comparison to buses and to the slightly lower productivity of SRT systems. The longer SRT trip lengths probably reflect the larger SRT service areas.

(B) Wait Times

The median wait time for DAB service is 15.0 minutes, varying from 5 to 37 minutes. Service levels are not significantly different from those of SRT systems, which reported a median wait time of 15 minutes, with a range of from 2 to 27 minutes. Although fewer systems reported

3.1.4
3.1.5

the promised wait time (the time the dispatcher tells the customer he will have to wait for pick-up), the data suggest that the median actual wait time is shorter than the promised wait time of 20 minutes. That is, buses typically arrive early and about 60% of the systems surveyed have an average arrival time within 10 minutes of the promised arrival time.

(C) Transfer Times

Few systems have attempted to integrate fixed-route and paratransit by coordinating transfers, hence there are little data available on transfer times.

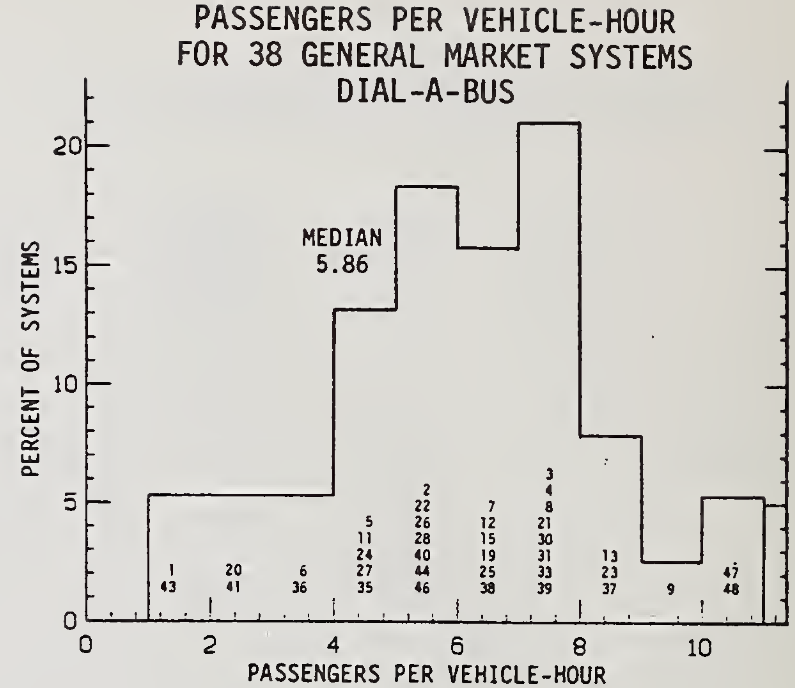
Transfer times should be evaluated by comparing them to the wait times incurred by non-transferring passengers. If the transfer times are no shorter than the wait times expected by non-transferring passengers, the means of coordinating transfers (if any) must be deemed ineffective.

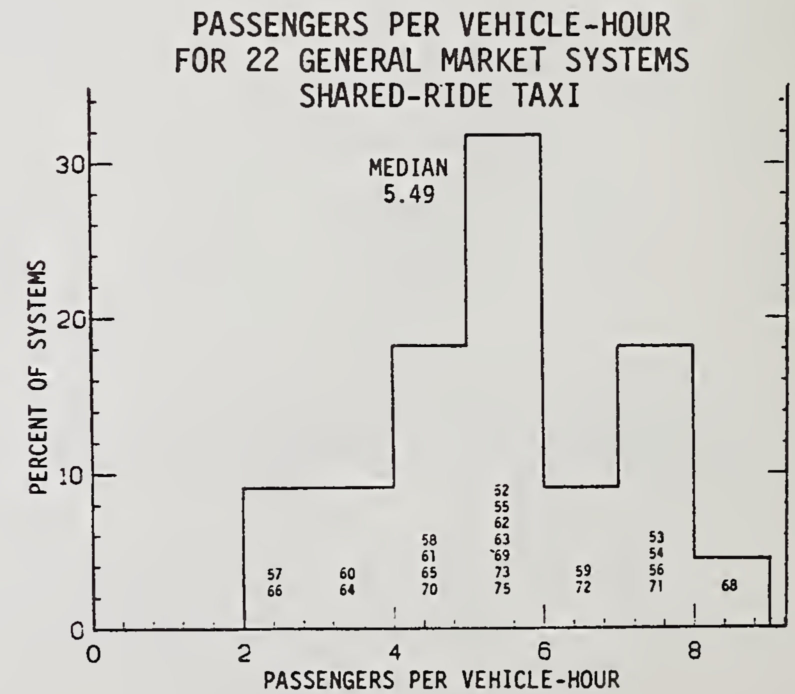
The types of transfer coordination that have been used in existing systems are described in Part II on Creating the System (Design 3.2.4).

3.1.5 Is it Cost-Effective?

(A) Productivities

The productivities (passengers per vehicle-hour) reported by currently-operated DAB systems range from 2.2 in Midland County, Michigan to 10.7 in Columbus, Ohio. The median value is 5.86 passengers per vehicle-hour, with a range of from 4 to 8 including about 68% of the systems surveyed (see exhibit).





(Source: SYSTAN)

3.2.4
for types of transfer
coordination

SRT productivity in terms of passengers per vehicle-hour is comparable to DAB service, ranging from 2.8 in Colton and Victorville, California to 8.70 in Adrian, Michigan, and having a median value of 5.49 passengers per vehicle-hour; about 77% of the systems have productivities of between 4 and 8 passengers per vehicle-hour.

(B) Costs

The median cost per vehicle-hour of DAB service is $10, ranging from $5.14 in Roscoman County, Michigan (discontinued) to $22.04 in Tracy, California. Of the systems responding, 58% reported costs of between $7 and $12. The wide range is due to the differences in organization, labor agreements, and equipment.

The median SRT service cost is about $10 per vehicle-hour, essentially the same as DAB service. The relatively small cost range of $9.00 to $14.65 indicates the fairly uniform nature of the taxi industry in terms of vehicles and operator remuneration.

Typical breakdowns of total capital and operating costs are shown in the facing exhibit. The first three systems are operated by DAVE Systems, Inc., and hence probably have compatible accounting systems. Although Rochester is a more expensive service on a vehicle-mile basis due to its higher labor costs, the relative cost breakdown in percentages is fairly representative of the other systems surveyed.

(C) Cost per Passenger and Revenue Recovery

The median cost per passenger of DAB service is $1.82, ranging from $.85 in Belding, Michigan to $4.47 in Placer County, California. The wide range between extremes may be traced to the same reasons cited in (B) above. However, in the case of cost per passenger, the effect of varying demand widens the range still further; just over 50% of the systems reported costs between $.90 and $2.00. The median revenue in DAB systems is $0.29 per passenger.

SRT costs per passenger vary from $1.05 in Adrian, Michigan to $2.94 in Pacoima (Los Angeles), California, a substantially lesser range than DAB service and have a median of $1.70, which is slightly lower than DAB service. Seventy-five percent of the systems have costs between $1.00 and $2.00 per passenger. The median revenue for SRT systems is $0.45 per passenger.

EXEMPLARY TOTAL MONTHLY COSTS

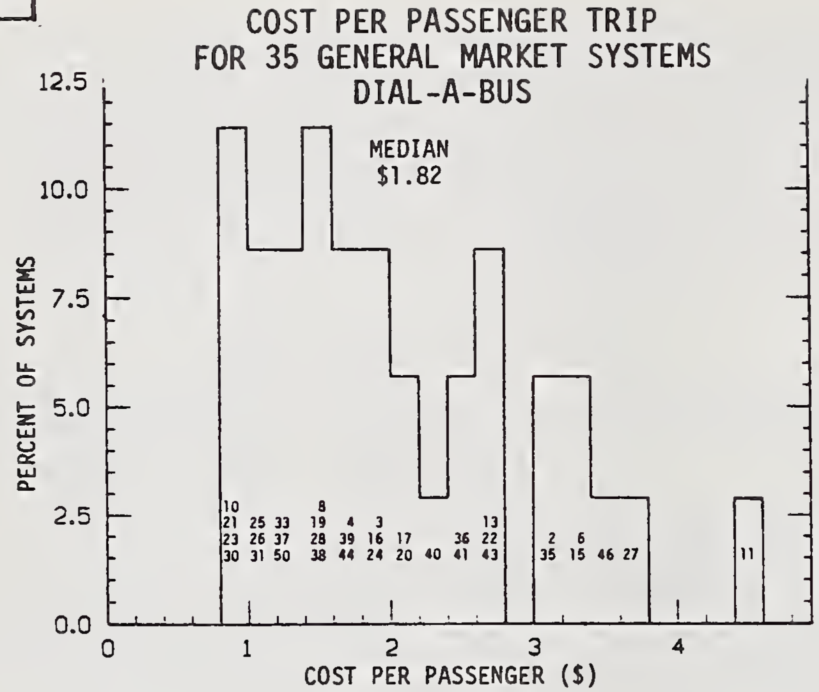
	Fairfield 12/75	Merced 11/75	Turlock 12/75	Rochester (Greece) 6/75 - 3/76
Operations				
Management & Labor	62.8%	57.7%	64.3%	68.0%
Vehicle Maintenance	9.0	14.7	11.1	10.9
Vehicle Insurance	5.6	4.9	3.1	----
Fuel	7.8	9.1	5.6	4.4
Telephone	0.7	1.8	1.3	----
Other	0.8	0.6	0.2	4.4
Capital				
Vehicle Depreciation	11.5	10.0	12.5	12.5
Radio Depreciation & Maintenance	1.8	1.2	1.9	----
Total Costs - %	100%	100%	100%	100%
Dollars/Vehicle Mile	.89	.80	.90	1.87
Dollars/Vehicle Hour	10.97	11.59	11.23	20.11
Total Costs	12,810	8,806	7,794	14,213
Total Miles	14,401	11,072	8,653	7,588
Total Hours	1,168	760	694	707
Total Passengers	8,013	6,850	4,613	3,827
Fuel	Propane	Gas	Diesel	Gas

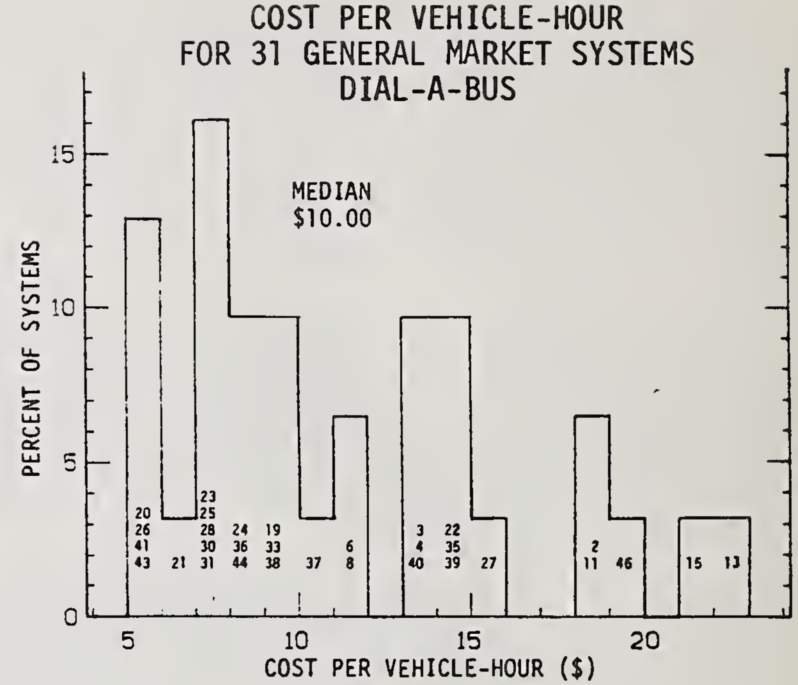
(Source: SYSTAN)

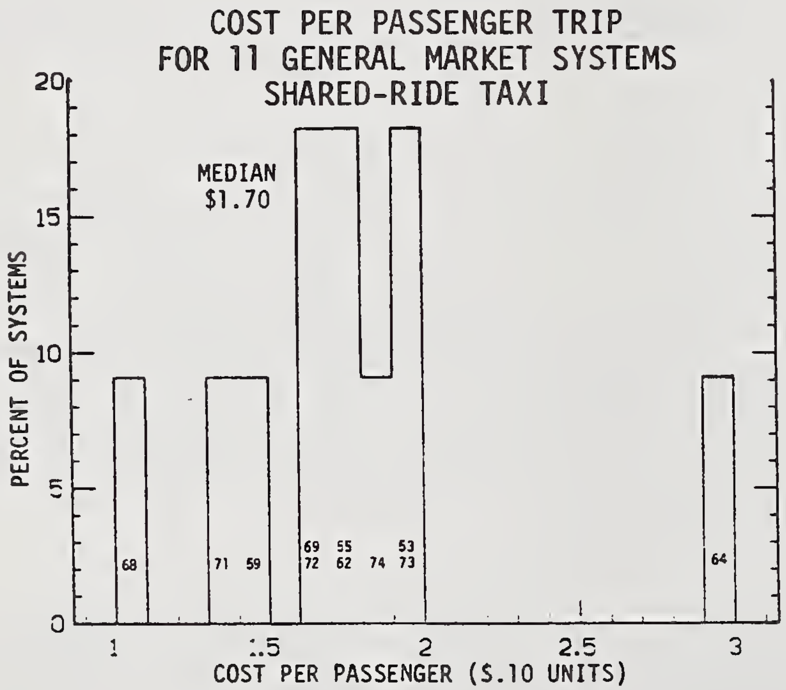
Go to PART 1 INTRO for guidance in evaluating alternatives

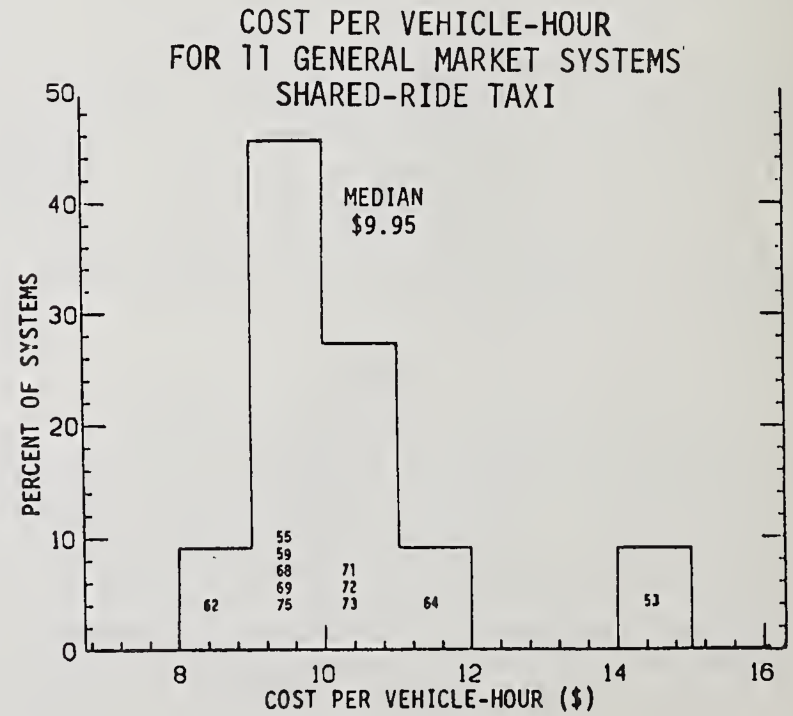
SCRAPS Section 5 for the use of models

3.1.5









(Source: SYSTAN)

(D) Paratransit Versus Conventional Transit

Guidelines for selecting among conventional transit and paratransit systems were discussed in Part I, the Introduction; the analytical tools for specific cases are discussed in SCRAPS, Section 5.

The comparison of productivities and costs of the same measures for paratransit and fixed-route systems is useful when the two alternatives are viable choices for providing similar service levels within the same service area. When comparing values, several factors should be considered. Although service levels in terms of wait time and ride time may be equivalent, the amount of personalized service that is provided make these systems intrinsically different. Paratransit service is tailored to passenger needs, sometimes offering riders door-to-door service. Paratransit and fixed-route transit can serve different community objectives, and hence attract different types and levels of demand.

The comparison of average figures for a nationwide set of transit systems is given below to help provide insights into the differences between services. They should not be used to suggest that one service is superior to another, as they often serve different markets. For example, many existing paratransit systems operate in sparsely-populated areas in which fixed-route service would not be viable.

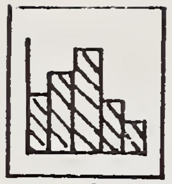
Nationally, average fixed-route vehicle productivities range from between 30 and 40 passengers per vehicle-hour. These figures include many routes in densely-populated areas where paratransit is not a potential competitor.

Even in less densely-populated cities, where reported fixed-route vehicle productivities range from between 20 and 30 passengers per vehicle-hour, these reported averages include figures from highly-productive routes in densely-populated corridors.

The productivities reported by general market systems range from 1.7 to 10.7 passengers per vehicle-hour, with a median of 5.76 passengers per vehicle-hour. This is considerably lower than reported fixed-route productivities, but comparisons from similar settings are only available in a few cases. The lower productivity of paratransit service reflects both the price paid for the added convenience of personalized service and the lower population densities of the areas currently served by paratransit.

The cost of conventional buses is in the range of $20 to $30 per hour, while 35 general market systems reported a range of $5.14 to $22.04 per hour, with a median of about $10 per hour. The median cost per passenger for conventional transit is probably less than $1.00 per passenger, whereas paratransit median cost is $1.78 per passenger.

In summary, paratransit systems have lower average productivities (passengers per vehicle operating hour), and cost less per vehicle operating hour than conventional fixed-route systems. In those cases where conventional transit and paratransit systems have comparable vehicle operating costs, such as when both are operated under the wage structure and work rules prevalent in conventional transit systems, the cost per passenger of paratransit service tends to be considerably higher than fixed-route system costs. In areas of light demand, however, paratransit may be a less expensive means of providing an equivalent service than is conventional transit.



4.1.1

4.0 TARGET MARKET SYSTEMS

4.1 Operational Data

4.1.1 Service Area Characteristics

Because the number of target market systems reporting was small compared to the number of general market systems, the results reported in this section are more prone to sampling error than the general market results. This is especially true for target market SRT systems, only seven of which responded to the survey.

DAB systems serving target markets typically:

- Serve large urban areas;
- Serve an entire city; and
- Provide the only transit in town.

SRT systems serving target markets typically:

- Serve small urbanized areas;
- Serve an entire city; and
- Provide the only transit in town.

(A) Service Area Size

About 40% of the DAB systems surveyed operate in large urbanized areas having a median size of 106 square miles. The size can vary widely, however, from .8 square miles in Kent, Ohio to 5,700 square miles in the six-county system in North Dakota. Forty percent of the DAB service areas are between 50 and 300 square miles in size; 30% operate in areas of over 350 square miles.

TARGET MARKET PARATRANSIT SETTINGS

	Percent of Systems*	
	% DAB	% SRT
Type of Setting	Nq=29	Nq=7
Large Urbanized Area	41.4	--
Small Urbanized Area	17.2	57.1
Small City	13.8	28.6
Rural	27.6	14.3
	100.0	100.0
Service Area Scope	Nq=28	No=7
Entire City	53.6	100.0
Section of City	25.0	--
Urban Area	35.7	--
Suburban Area	14.3	14.3
Entire County	32.1	--
Rural	28.6	14.3
	189.3	128.6
Modes Integrated with Paratransit	No=24	Nq=5
Local Fixed-Route Bus	20.8	--
Intercity Fixed-Route Bus	4.2	--
DRT in Other Zones	8.3	--
No Other Service	66.7	100.0
Rail	--	--
Other	8.3	--
	108.3	100.0

*Adjusted Frequency (%)

Totals higher than 100% due to multiple responses.

(Source: SYSTAN)

In contrast to DAB services, SRT services operate in small urbanized areas or small cities. The median SRT service area is 22 square miles, and the range is 3 to 94 square miles. Three-quarters of the systems operate in areas of less than 25 square miles.

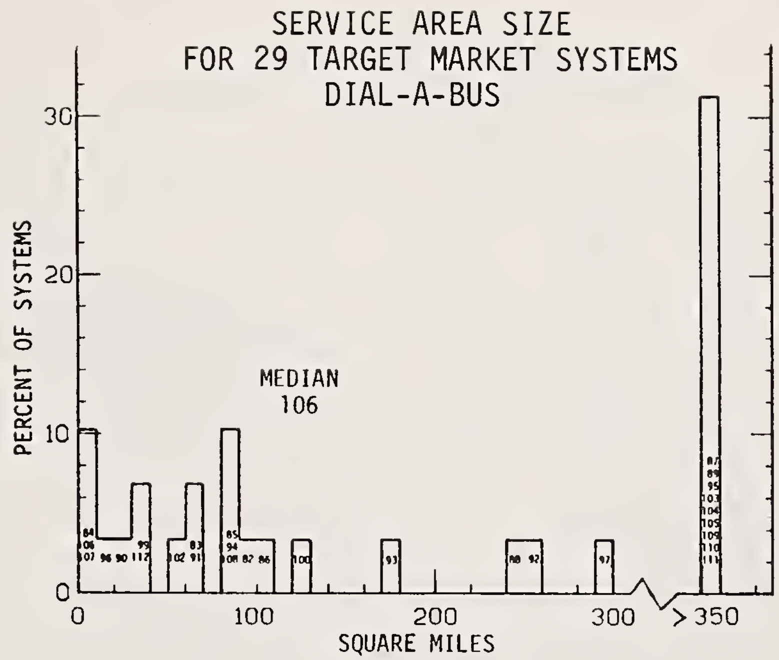
The differences between characteristic DAB and SRT systems are probably related to the availability of service supply prior to the installation of the target market systems. In small urban areas and small cities, taxi companies typically provide the only existing transit, and can provide shared-ride target market service more easily than attempting to create a new service with a new operator. In large urban areas, existing transit operators provide a convenient, established base of operations for target market service.

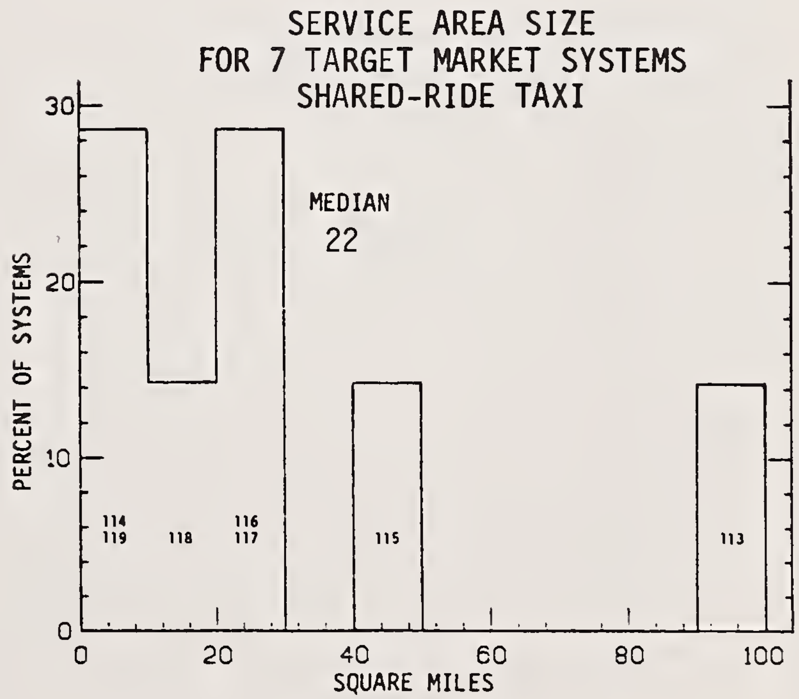
(B) Eligible Populations

DAB target market services operate in areas having a total median population of 159,000, about 10% of which are eligible for the service. Eligible populations for these services range from 75 persons in Kent, Ohio to 220,000 in a system serving 89 counties in Missouri.

The total populations in SRT target market service areas have a median of 60,000 persons, and eligible populations generally represent about 5% of that number. Eligible populations range from approximately 2,200 in Palo Alto, California to 7,000 in Marysville-Yuba City, California.

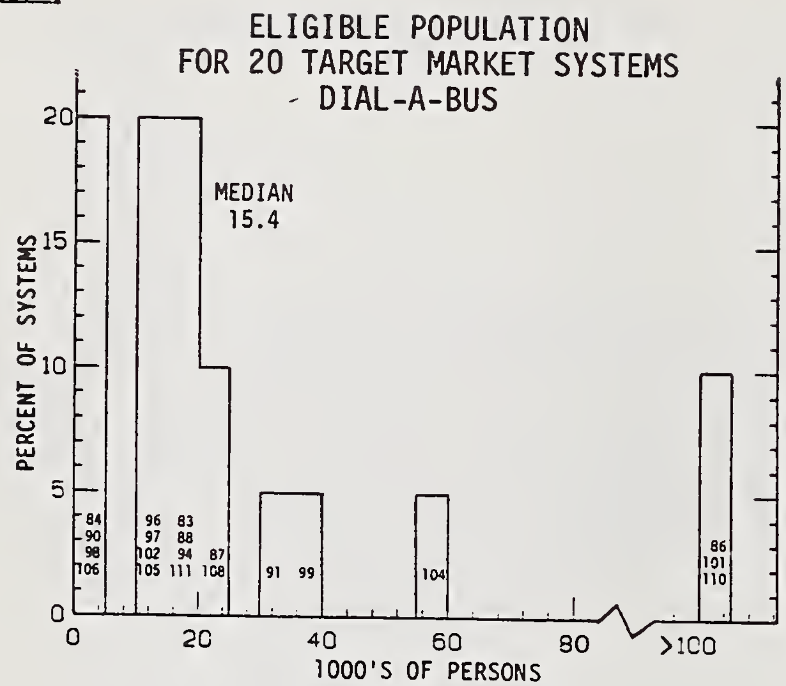
The distribution of eligible populations is shown in the exhibit. The small eligible populations in SRT service areas reflect the smaller service area.

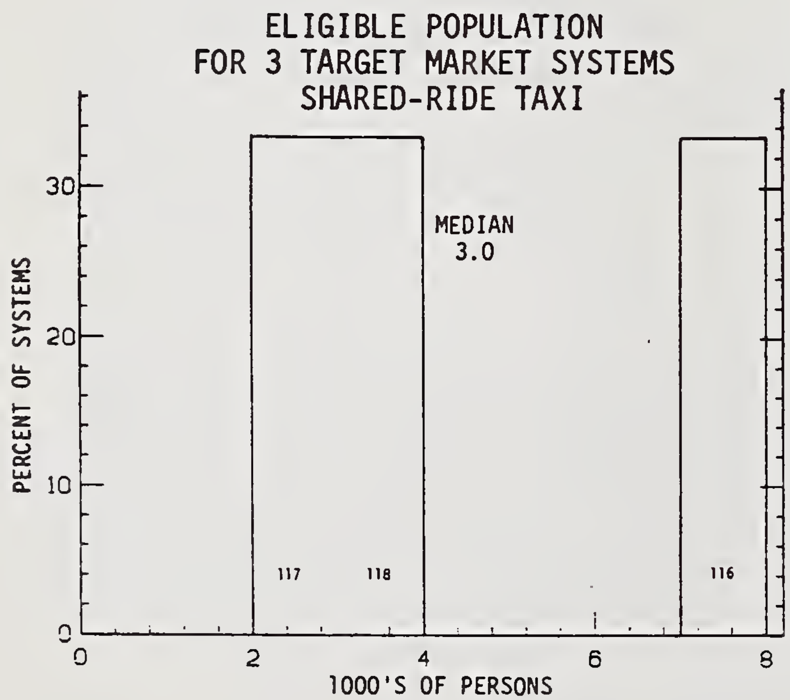




(Source: SYSTAN)

4.1.1
4.1.2





(Source: SYSTAN)

(C) Eligible Population Densities

The median population density of eligible users for DAB systems is 150 potential riders per square mile. For SRT systems, the median density is 200. The distribution of these data is shown in the exhibit on the next page.

The small number of systems providing data does not allow for conclusions concerning density.

4.1.2 Supplying the Service

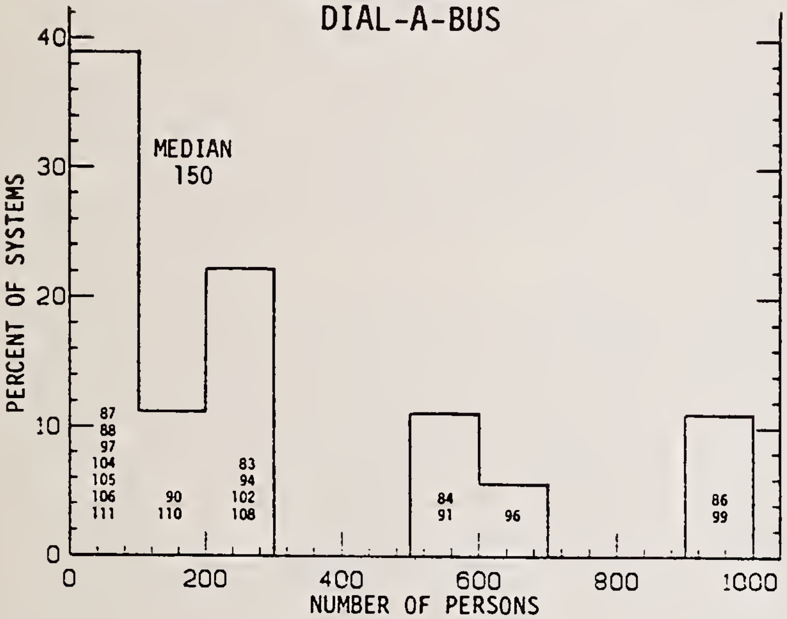
(A) Service Patterns

The majority of DAB services provide many-to-many service both during the peak and off-peak periods. In addition, they generally provide a variety of other route- or schedule-constrained services (see exhibit).

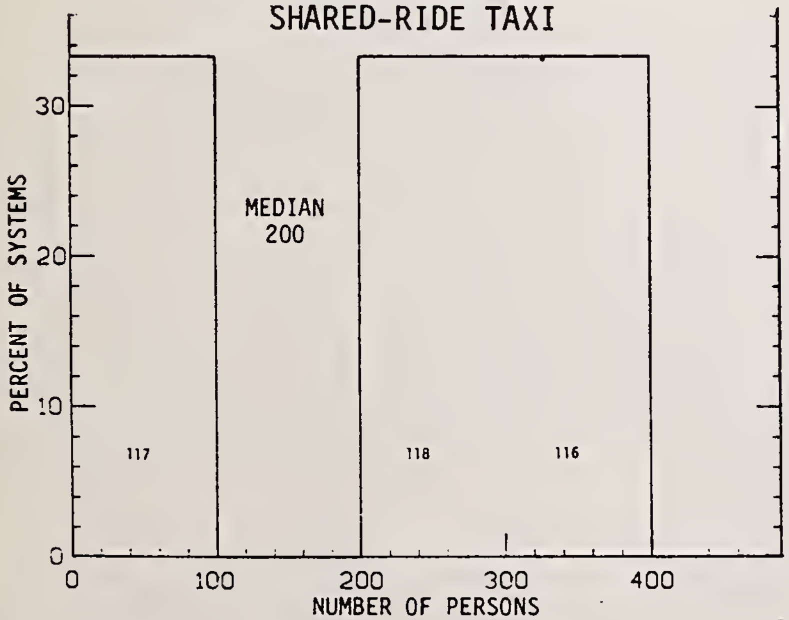
Six of the seven SRT services responding offered many-to-many service. As with DAB service, however, many-to-few and many-to-one services were provided as well.

The prevailing method of access for target market services is the telephone. Advance reservations can be made on almost all DAB target market services, and a high percentage (69%) offer subscription service. In contrast, almost all SRT services offer immediate service, while only half provide advance-request service and none provide subscription service (see exhibit on following page).

ELIGIBLE POPULATION PER SQUARE MILE
FOR 18 TARGET MARKET SYSTEMS
DIAL-A-BUS



ELIGIBLE POPULATION PER SQUARE MILE
FOR 3 TARGET MARKET SYSTEMS
SHARED-RIDE TAXI



(Source: SYSTAN)

TARGET MARKET SERVICE PATTERNS

	DAB	SRT
SYSTEMS RESPONDING	30	7
Many-to-One Peak	30.0%	14.3%
Many-to-One Off-Peak	23.3	14.3
Many-to-Few Peak	30.0	28.6
Many-to-Few Off-Peak	33.3	28.6
Many-to-Many Peak	60.0	85.7
Many-to-Many Off-Peak	66.7	85.7
Route Deviation Peak	6.7	0
Route Deviation Off-Peak	10.0	0
Point Deviation Peak	-	0
Point Deviation Off-Peak	-	0
Other Peak	3.3	14.3
Other Off-Peak	3.3	14.3
TOTAL	266.6%*	285.8%*
SYSTEMS RESPONDING	29	6
Immediate	31.0%	83.3%
Subscription	69.0	-
Advanced	96.6	50.0
TOTAL	196.6%*	133.3%*
SYSTEMS RESPONDING	28	6
Phone	100.0%	100.0%
Hail	3.6	16.7
Fixed Stops	7.1	-
Other	3.6	-
TOTAL	114.3%*	116.7%*

* Response higher than 100% due to multiple answers.

(Source: SYSTAN)

4.1.2
4.1.3

(B) Vehicle Fleet Size

DAB fleet sizes have a median value of 5.2 vehicles, and a range of from 1 to 50; 40% of the systems surveyed have fleet sizes of from 3 to 6 vehicles (see exhibit).

SRT fleet sizes are slightly smaller, having a median of 4 vehicles and ranging from 1 to 32 vehicles.

The larger SRT fleet sizes are due to the higher population and demand densities found in the areas served by SRT systems.

(C) Service Hours

The median length of daily service by DAB systems is 10.8 hours per day. Hours vary widely, from 6 to 18 hours. The five SRT systems reported between 8 and 12 daily service hours, with a median of 9.2.

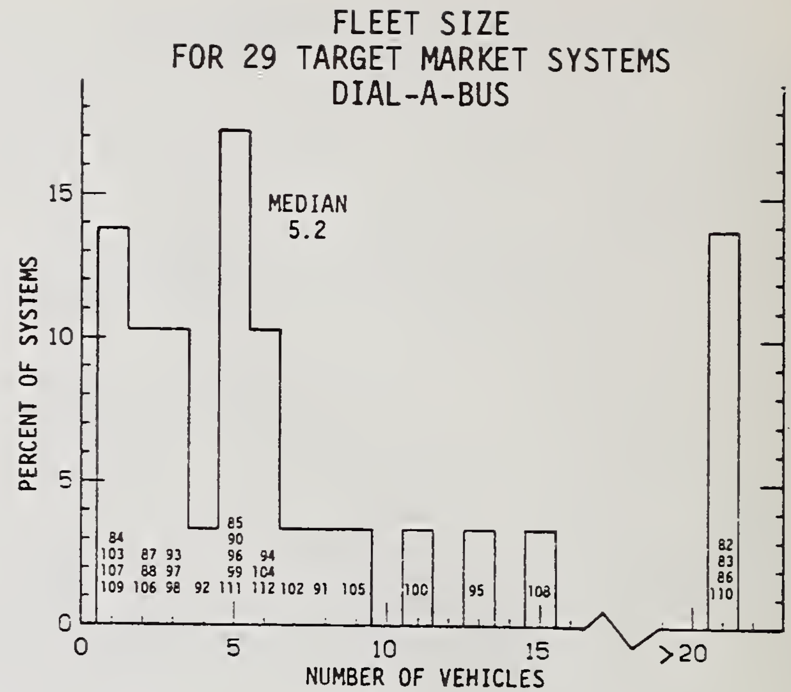
(D) Fares

About half of the DAB services are fare-free. When charged, fares range from $0.25 to $1.00. Of the four reporting SRT systems, one has a $0.25 fare and three charge $0.50 (see exhibit on following page).

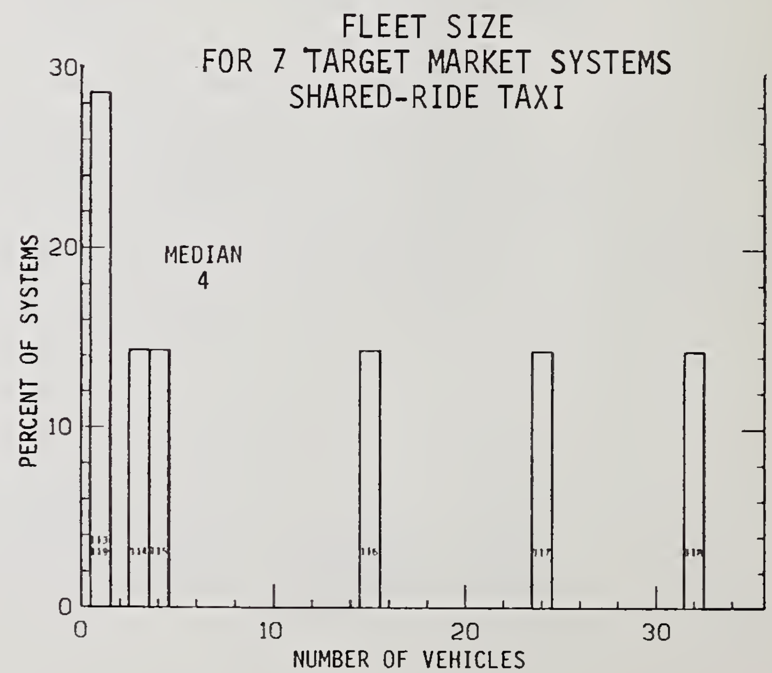
4.1.3 Service Users

(A) Ridership

The median weekday DAB ridership is 132 persons, ranging from 7 persons in Western Nebraska to 1,480 riders in Rhode Island. SRT services have a median weekday ridership of 50 persons, ranging from 14 in Fremont, California to 285 in Marysville-Yuba City, California.



(Source: SYSTAN)



(B) Demand Density

The demand density of DAB systems is 8.0 passengers per day per 1,000 eligible residents. This density ranges markedly, from 2.5 in Syracuse, New York to 10.1 in Montebello, California. The median number of person-trips per square mile is .15, ranging from .001 in Western Nebraska to 2.44 in Kent, Ohio (see exhibit on following page).

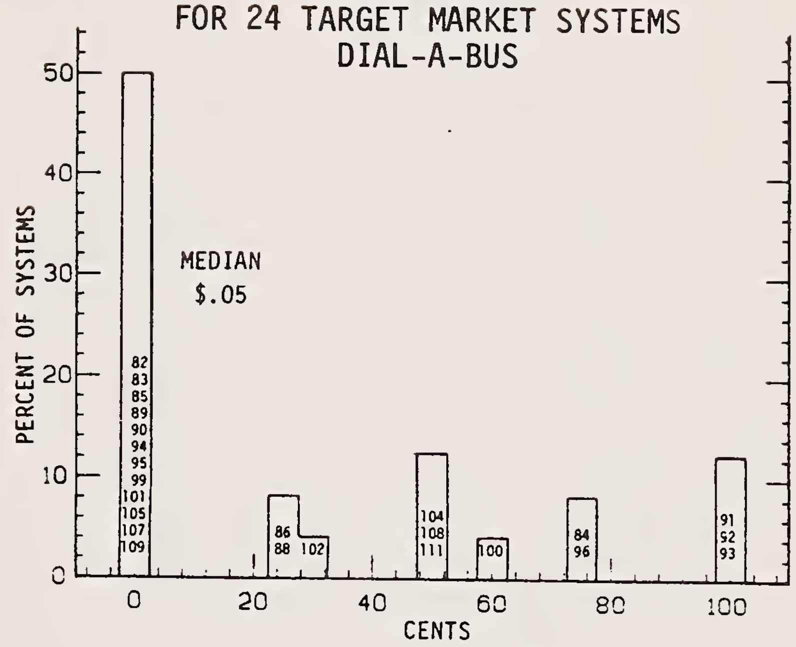
SRT systems experience a median demand density of 26.7 persons per day per 1,000 eligible residents, ranging from 10.3 in San Leandro, California to 40.5 in Marysville-Yuba City, California. The trips per square mile per hour for these systems has a median value of .83, ranging from .01 to 5.7.

The higher demand density of SRT systems as compared to DAB systems is probably due to the nature of the service areas, but is unknown pending more detailed investigation.

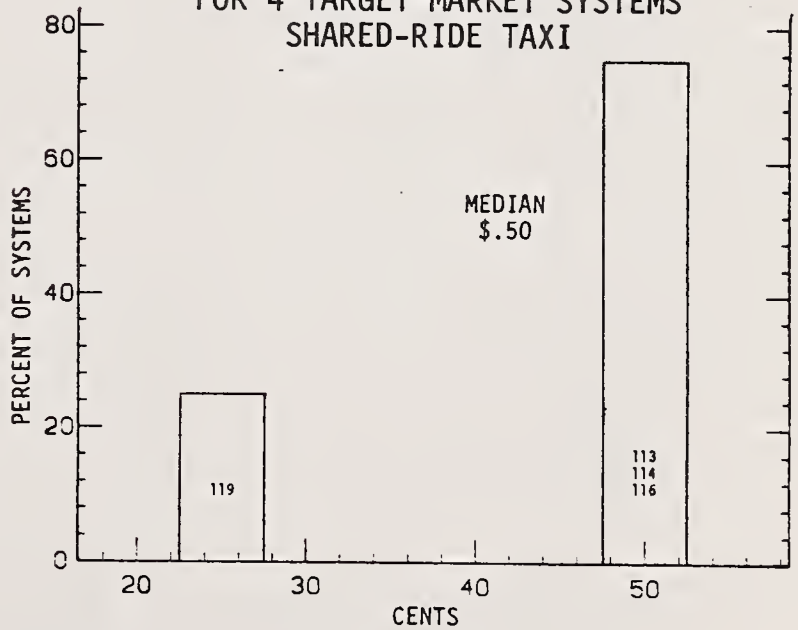
(C) Rider Characteristics

Examples of the user characteristics are listed in an accompanying exhibit for two DAB target market systems (Baton Rouge and Syracuse) and two mixed DAB/SRT systems (Cleveland and Dade County). Although the data are sketchy, they indicate that there are a variety of users served by target market systems with a large proportion of elderly. Generally, the greatest proportion of users are women and the most common trip is for medical purposes. The services seem to replace being driven as the most common alternative mode. The Syracuse system serves a relatively high proportion of trips that would otherwise not be made.

BASE FARES
FOR 24 TARGET MARKET SYSTEMS
DIAL-A-BUS



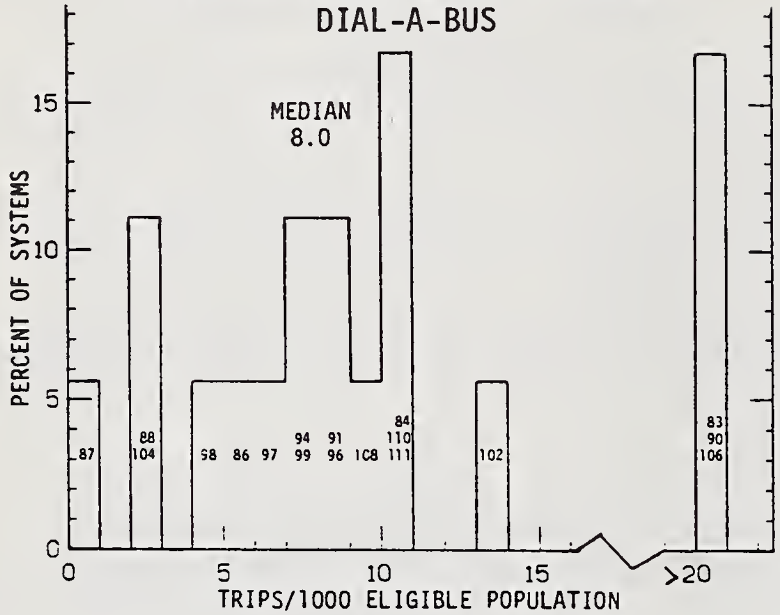
BASE FARES
FOR 4 TARGET MARKET SYSTEMS
SHARED-RIDE TAXI



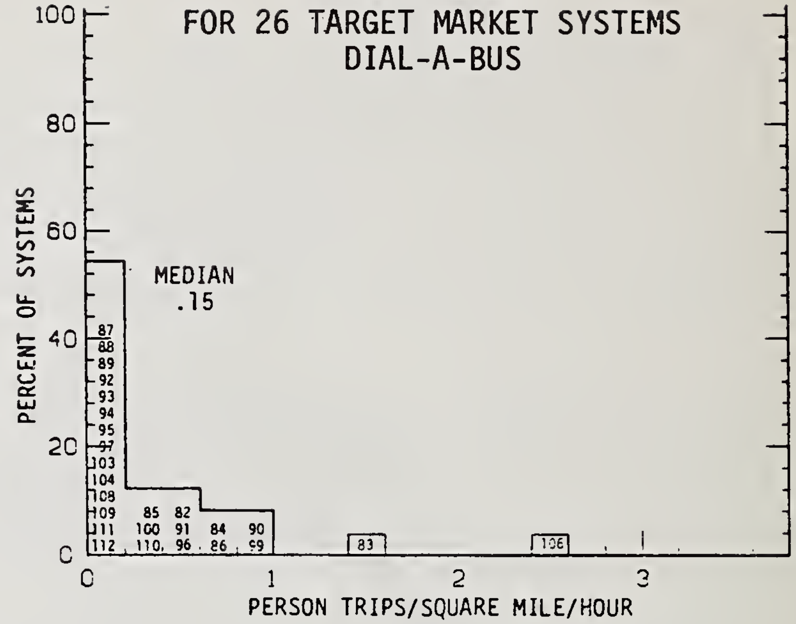
(Source: SYSTAN)

4.1.3

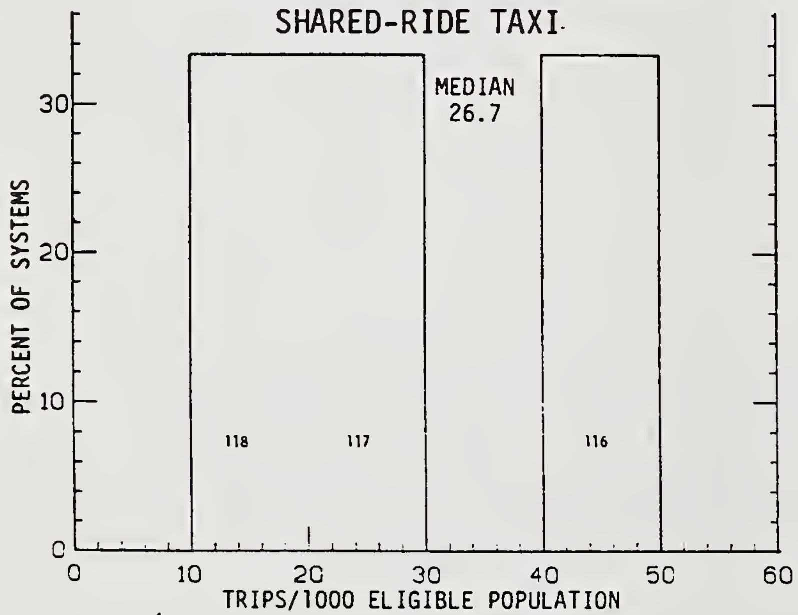
PASSENGERS PER DAY
PER 1000 ELIGIBLE RESIDENTS
FOR 18 TARGET MARKET SYSTEMS
DIAL-A-BUS



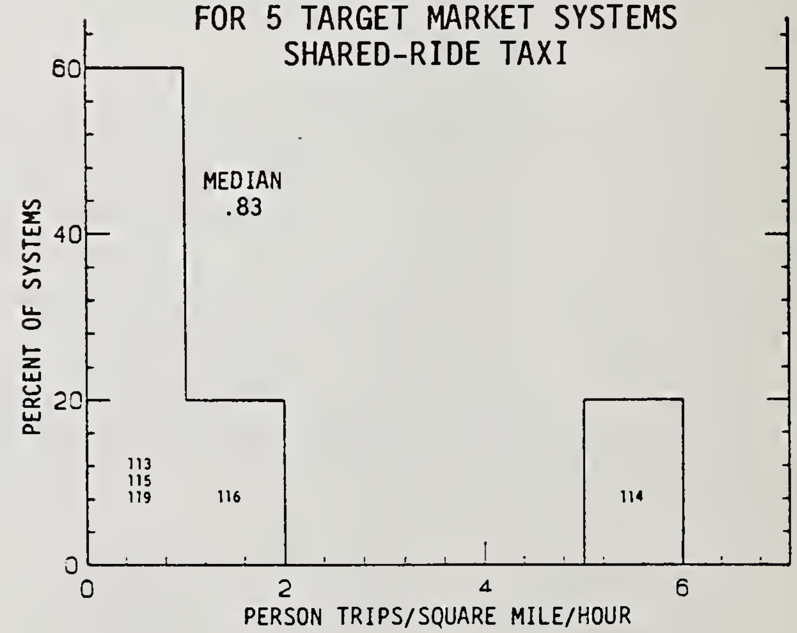
DEMAND DENSITY
FOR 26 TARGET MARKET SYSTEMS
DIAL-A-BUS



PASSENGERS PER DAY
PER 1000 ELIGIBLE RESIDENTS
FOR 3 TARGET MARKET SYSTEMS
SHARED-RIDE TAXI



DEMAND DENSITY
FOR 5 TARGET MARKET SYSTEMS
SHARED-RIDE TAXI



(Source: SYSTAN)

TARGET MARKET RIDER CHARACTERISTICS

Variable		Cleveland Ohio (Mixed)	Syracuse New York (DAB)	Dade County Miami Florida (Mixed)	Baton Rouge Louisiana (DAB)
Sex:	Male	8.0%	14.9%	N/A	48.0%
	Female	92.0	83.9	N/A	52.0
Age:	Under 18	0.0	N/A	2.9 (Under 21)	43.4 (Under 21)
	18 - 44	5.5 (20-59)	13.1 (Under 60)	25.0 (21-49)	26.4 (21-39)
	45 - 64	6.0 (60-64)	6.8 (60-64)	28.8 (50-64)	23.9 (40-64)
	65 and Over	88.5	80.1	43.3	6.3
Cars	0	N/A	59.9	N/A	12.7
in	1	N/A	N/A	N/A	42.4
House-	2	N/A	N/A	N/A	37.4
Hold:	3+	N/A	N/A	N/A	7.5
Purpose of Trip:					
Work		N/A	2.3	12.7	N/A
School/Soc. Serv.		N/A	N/A	11.4	N/A
Medical		49.5	46.8	24.0	87.0
Shopping		47.5	0.9	19.0	N/A
Recreation		32.0	7.3	17.7	N/A
Other		14.0*	42.7*	15.2	13.0
Alternate Mode:					
Bus		33.0	11.1	9.0	20.4
Walk		42.0	0.6	N/A	2.5
Taxi		8.0	21.9	28.0	2.5
Drive		7.0	1.2	N/A	5.7
Be Driven		38.5	15.8	49.0	45.2
No Trip		10.0	22.3	N/A	2.5
Other		8.0	16.1	N/A	18.5

*Figure includes multi-purpose trips.

(Source: Kendall (TSC), Reference 19; Cleveland Regional Transit Authority, "Community Responsive Transit in Cuyahoga County"; Silverman, "Taxicabs for Transporting the Handicapped: The Dade County Experience"; SYSTAN, "Syracuse, New York Evaluation Plan")

4.1.4
4.1.5

4.1.4 Service Quality

(A) Ride Time and Trip Lengths

The median reported average ride times for DAB systems is 20 minutes for trips having a median length of 4.4 miles. Average system ride times vary from 3 to 90 minutes. Ride time data for SRT systems were available from only two systems, reporting 15 and 20 minutes.

(B) Wait Times

The median average wait time for DAB systems is 20 minutes, ranging from 5 to 35 minutes. When compared to the reported median promised wait time of 20 minutes, it appears that DAB vehicles generally arrive on time.

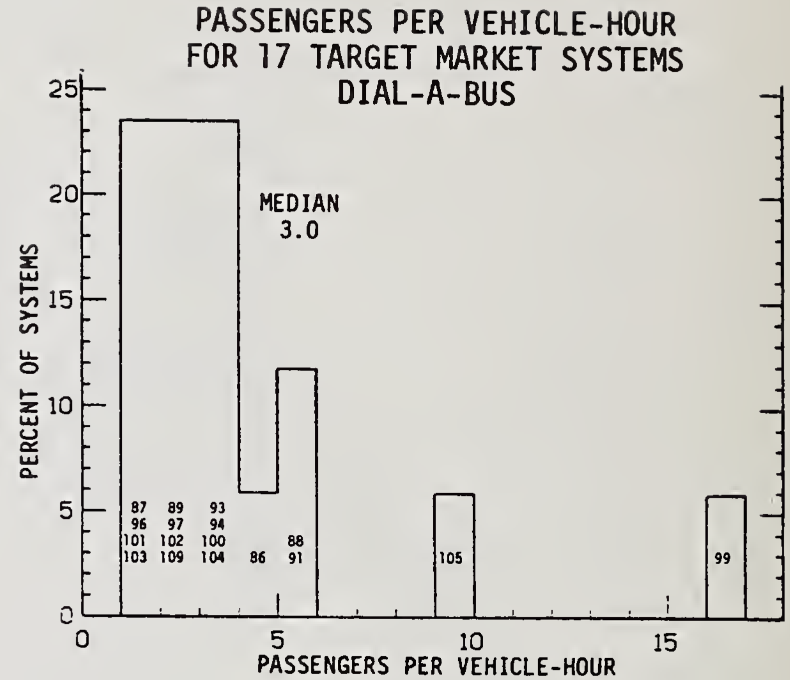
For SRT services, the median wait time is 25 minutes, ranging from 15 to 45 minutes. SRT promised performance does not fare as well generally as DAB, keeping riders waiting longer than the promised median wait time of 15 minutes.

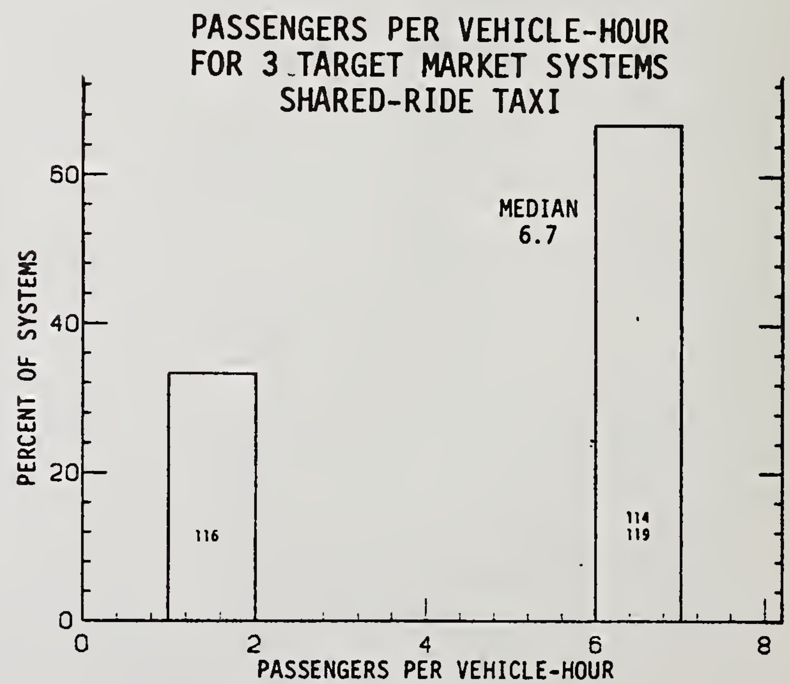
4.1.5 Is it Cost-Effective?

(A) Productivities

The median productivity (passengers per vehicle-hour) of DAB target market systems is 3.0 passengers per vehicle-hour, ranging from 1.0 in Missouri to 16.2 in Worcester, Massachusetts.

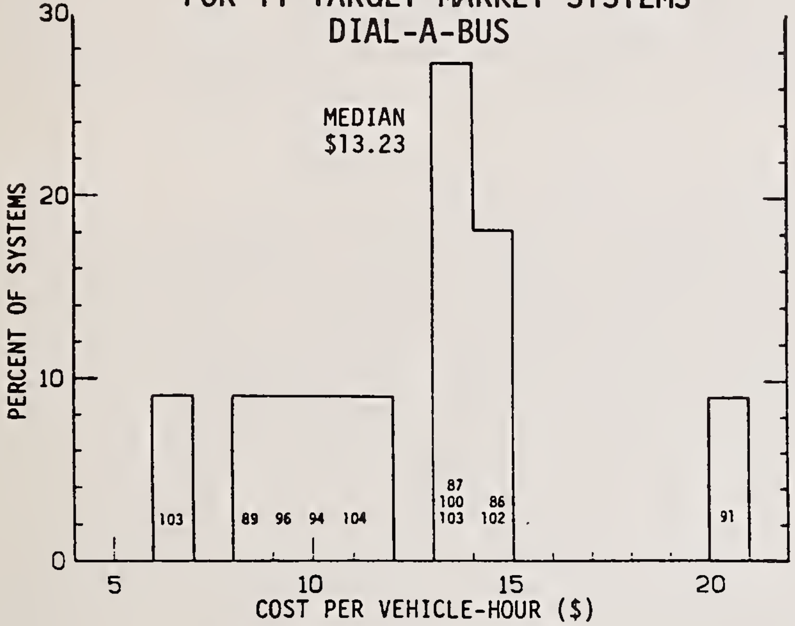
The productivity of SRT services ranges from 2.0 to 6.8 passengers per vehicle-hour for the three systems reporting.



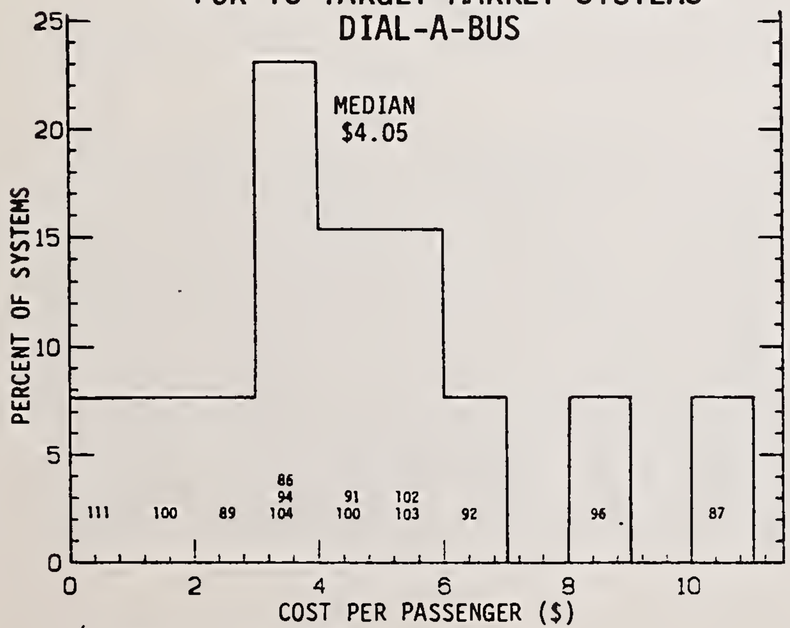


(Source: SYSTAN)

COST PER VEHICLE-HOUR
FOR 11 TARGET MARKET SYSTEMS
DIAL-A-BUS



COST PER PASSENGER TRIP
FOR 13 TARGET MARKET SYSTEMS
DIAL-A-BUS



(Source: SYSTAN)

4.1.5
4.2.1

(B) Costs

The cost per vehicle-hour for DAB target market services is $13.23, ranging from $6.90 to $20.26 (see exhibit). These operating costs yield a median cost of $4.05 per passenger.

Cost information is available for only one SRT target market system. The cost per vehicle-hour is $14.16 and the cost per passenger is $2.11.

4.2 Special PDIOE Considerations

This section contains planning, design, implementation, operation and evaluation information which is specifically applicable to target market systems. The material supplements material contained in Part II.

4.2.1 Planning

(A) Definition

Target markets are groups of people who have special transportation needs that cannot be met by conventional transportation. Sometimes referred to as transit-dependent, these people have limited mobility due to one or more of the following characteristics:

- Physical handicaps;
- Low income levels;
- No automobile availability;
- Non-drivers, by choice or lack of opportunity; and
- Too young or too old to qualify for a driver's license.

Those persons without access to transportation because of the limited routing or scheduling of existing transit are not included in this definition of target market groups. Target markets most often consist of the physically handicapped and the elderly.

(B) Rationale for Target Market Service

There are many motivations and arguments for establishing service for target markets. In many communities, transit is considered to be a social service to help the handicapped live more productive lives and to increase their well-being. It can also be argued that target market systems establish modal equity; that is, they balance the large part of many communities' budgets that support the automobile through roads, traffic control, etc. In situations where target market groups are chauffeured by individuals or social service organizations in a fragmented, unorganized fashion, the community stands to improve cost-effectiveness and efficiency by initiating a single target market paratransit service.

Whatever the motivation, the number of communities that are supporting target market service is growing appreciably.

(C) Initial Planning Steps

Initiating planning steps for the target market system follow the same procedure outlined for general market systems in Part II. However, additional considerations should be made when gathering background information to identify existing demand, target market characteristics and needs, and the number and extent of existing services.

Existing demand and an inventory of existing services can be determined from the records of existing providers of transportation, which may include transit agencies, taxis, social service agencies, and housing providers. As much detailed information as possible should be collected on the social and economic background of the people served, their trip patterns, and trip purposes, for use in designing the prospective system. Social service agency providers can be identified from the telephone yellow pages, listed under "Social Service and Welfare Organizations."

Study of the existing travel habits of the mobility-limited clientele will reveal only the tip of the iceberg, since typically there is a very large, unknown number of persons who do not use transit, but could benefit from enhanced mobility. Therefore, attempts must be made to identify the size of the market needing transportation. This task is discussed in more detail in Section 4.2.5. When estimating the total size of the mobility-handicapped population, remember that this market consists of different persons with different disabilities and different needs (see exhibit). Throughout the system design process, remain sensitive to the barriers confronting the target market population. Some agencies have developed this sensitivity by having decisionmakers try getting around in a wheelchair.

(D) Service Options

Planners generally have the following major service options for providing enhanced mobility to target markets:

- Install wheelchair lifts or ramps in existing conventional transit vehicles;
- Create target market paratransit systems;
- Create general market paratransit systems; or
- Coordinate efforts of social service agencies to provide their own paratransit services.

The planner is not restricted to considering only one option, as it is common to find successful combinations of these options. Coordination of existing services

HANDICAP RELATED TO FUNCTIONAL TRAVEL REQUIREMENTS

Function	A	B	C	D	E	F
Walk or go more than one block				x		x
Move in crowds	x		x	x	x	x
Stand or wait				x	x	x
Board quickly	x		x	x	x	x
Climb shallow, short stairs			x	x		
Climb steep or long stairs			x	x	x	x
Use inclines				x		
Deposit exact fare	x			x	x	x
Maintain balance while standing in moving vehicle (with aid of pole, seat, etc.)			x	x	x	x
Sit down, stand up			x	x		
Respond to visual cues	x					
Respond to audio cues		x				

KEY:
x: Individual cannot perform function without substantial difficulty.
A: Visuallly inpaired.
B: Deaf.
C: Wheelchair user.
D: Walker user.
E: Uses other special aid.
F: Other mobility limitation.

SOURCE: U.S., Department of Transportation, Urban Mass Transportation Administration and Transportation Systems Center, *The Handicapped and Elderly Market for Urban Mass Transit.*

4.2.5 for estimating target market population size
4.2.2 for coordination strategy

has great potential for providing cost-effective, improved mobility because it strives to make better use of existing facilities, equipment, and funding. Therefore, some attempt should be made to coordinate services, even if none of the other options are pursued. (For information on coordination strategy, see Section 4.2.2.) The merits and drawbacks of the other alternatives are discussed below.

(i) <u>Install Wheelchair Lifts or Ramps</u>. In considering the various options, the planner must weigh the tradeoffs between equality, accessibility, and cost. Accessibility and cost affect mobility, while equality pertains to other aspects of the quality of life.

The criteria of equality is best served by installing lifts on all fixed-route buses. Many spokespersons for target market groups have campaigned for the rights of the mobility-impaired to have access to the regular transit system...to ride with everyone else. They reject the separate but equal approach which is embodied in paratransit services for target markets.

The proponents of fully-accessible fixed-route systems are supported by the unique economics imposed by federal funding programs. A few operators have concluded that a wheelchair lift on every fixed-route vehicle is a more cost-effective means of meeting accessibility requirements than any paratransit service. This is because UMTA capital grants can be used to pay for 80% of the investment in lifts, but only 50% of the cost of operating a target market service. This difference in subsidies typically overshadows the difference in total cost over time of the two options. It tips the financial balance in favor of fully outfitting conventional bus fleets with lifts.

Fully-accessible fixed-route buses do not, however, provide total accessibility to the transit system. Access to the bus stop is clearly an impediment for many handicapped people: Lifts do not solve the problem of reaching

Travel Barriers Confronting the Disabled and Elderly

Physical Barriers	Operational Barriers
<u>Vehicles</u>	<u>Vehicles</u>
High step required to enter	Frequency of service
Difficult to get into or out of seats	Driver assistance/attitude
Seats not available/forced to stand	Acceleration/deceleration
Difficult to reach handholds	Information presentation
Cannot see out for landmarks	Schedules maintenance
No place to put packages	Inadequate or inappropriate routes
Cannot see or hear location information	Too many transfers
Nonvisible signs	
<u>Terminals</u>	<u>Terminals</u>
Long stairs	Employee assistance/attitude poor
Long walks	Information clarity and dissemination inadequate
Poor fare collection facilities	Length of stops too short
Poor posting of information	Crowd flow nondirected
Poor crowd flow design	Little or no interface with other modes
Insufficient seating	
Little interface with other modes	
<u>Transit Stops</u>	<u>Transit Stops</u>
Insufficient shelter	Poor location: for safety; for convenience
Platform incompatible with vehicle	Not enough stops
Inadequate posting of information	Information displayed insufficient or confusing

Source: U.S., Department of Transportation, Urban Mass Transportation Admininstration and Transportation Systems Center, *The Handicapped and Elderly Market for Urban Mass Transit.*

the bus stop. Door-to-door services provide superior access for the physically-limited, and should be weighed carefully as a service option in communities with strict handicapped needs. The Federal Register of April 30, 1976 focused on this issue:

> ...The comments on the proposed regulations revealed substantial disagreement over the best type of service for wheelchair users--accessible fixed route service, demand-responsive van or small-bus service, subscription service, subsidized shared-ride taxi service, or some combination of these or other services. Given present knowledge, we cannot say that one of these services or even one combination is best for all communities. In fact, it is likely that site-specific planning and tailoring of appropriate services will always be necessary. We say this with full appreciation of the psychological and rehabilitation advantages of integrating wheelchair users into regular as opposed to specialized transit service (Reference 149).

(ii) Create Target Market Paratransit. Various forms of target market services are possible. Many systems make efforts to coordinate and aggregate demand in order to improve productivity by defining quasi-fixed schedules for trips to specified activity centers. This method has been used successfully in Rochester, New York. Another method of aggregation is to require access by advance reservation only, so that tours can be efficiently planned. Some systems (e.g., Syracuse, New York) use a call-back procedure to check back with the user and modify their requested travel times to conform to efficient tours.

Lifts can be added to both conventional buses and to target market paratransit vehicles used to feed them, but this strategy has many shortcomings. Although it offers both equality and accessibility, the costs of this combination may be high, since the system must incur extensive capital costs for the lifts and paratransit vehicles, and at the same time bear the yearly operating costs of the paratransit service. The combined services also require low-mobility users to face the inconvenience of transfers.

(iii) Create General Market Paratransit. Another approach to balancing equality and accessibility is the creation of general market paratransit services that give preferential service to target market users.

Preference can be given through reservation and seating priority and fares. The rationale supporting this option is that the cost of the combined services will be less than that of a target market service alone. Productivities and revenues will be higher due to the inclusion of general market users. This approach may or may not hold true in every case; costs, ridership, and fares are all critical variables. Planners must evaluate the feasibility of these options for their individual situation.

It is absolutely essential to effective planning to solicit community input on the choice of service options. Target market representatives in particular need to be heard.

A word of caution to planners is necessary concerning fair representation of the target market population. The question has been raised of whether those who have the mobility to be active as spokespersons for the low-mobility population can be sensitive representatives. By virtue of their mobility, they may not fully appreciate the problems of those who are less mobile. The syndicated columnist Neal Pierce quotes Elizabeth Myhre, Spokane County's director of transportation for the elderly and handicapped, as saying:

4.2.1

> The "wheelchair independents" are highly organized, vocal, articulate and politically active, while, on the other hand, the "wheelchair dependents," who need specialized dial-a-ride service, are fragmented, lack any organized advocates, and remain withdrawn and timid."

Heeding this caution, planners are advised to seek channels for communicating with target market groups. It may be necessary to reach out a little more, and solicit ideas more rigorously than was necessary in planning, only because of the limited mobility of the target market population. For this reason, their interests and needs for transportation cannot be viewed as any less vital than those of the general population.

(E) Constraints

The purpose of this section is to investigate those federal, state and local regulations which may constrain the choice of service options. Some of these regulations include:

- State and local regulations may dictate constraints related to the competition with or use of private transportation operations.
- Taxi regulations may constrain their ability to provide shared-ride target market services.
- State legislation may restrict the ability of communities to create new services which compete with private operators, especially the legislation which creates transit districts.

See Section 4.2.4 for a discussion of restrictions.

4.2.4 for institutional factors affecting planning

4.2.3 Target Market Funding

Federal policies are only applicable if federal funding is to be used, but state regulations may be tied to funding or may be imposed directly, regardless of the type of funding being used. Regional Transportation Planning Agency (RTPA) approval may also be necessary when submitting an application for state or federal funding.

With the usual "whereas's" and "wherefore's", some RTPA's have reinterpreted federal policies to fit their own transit operator requirements in order to receive RTPA approval for federal funding. In the San Francisco Bay Area, the Metropolitan Transportation Commission has stated that "all vehicles of a public mass transportation operator's conventional fixed-route bus system shall be fully accessible at the base service frequency" (the level of vehicle service common during the day or the off-peak frequency). (Resolution of September 28, 1977)

Section 4.2.3 presents more detailed information on services and funding restrictions at the local, state and federal levels.

In summary, federal regulations tied to funding may affect the choice between transit and paratransit, but not the choice of paratransit options. State, regional and local regulations can also affect choices, and planners must consider their own areas when making these choices.

<u>Representative Planning Input</u>

To become familiar with the specific needs of the target market to be served, planners must be sure that a representative number of persons from that market are interviewed.

4.2.2 Coordination

For many communities, coordination of existing transportation facilities, equipment and services for targeted groups has resulted in both improved and expanded transit services at a relatively low cost per passenger. The relatively rapid growth of social service agencies with their own transportation services during the 1960's and 1970's has created a tangled web of overlapping and frequently duplicated services across the country. In the San Francisco Bay Area alone, approximately one-half of the 1,900 human service agencies own their own vehicles or purchase transportation services for their clients (Reference 128); these services are available to city residents in addition to the extensive public and private transit and paratransit services.

When applied to transit, coordination can be defined as the bringing together of a number of social service or other community agencies in order to cooperatively develop a transit system that will serve all of their combined needs (Reference 141).

(A) The Advantages of Coordination

The potential advantages to be gained from coordination of different resources are listed below:

- Eliminates duplication and overlapping of transportation services;
- Lowers capital equipment and vehicle costs, insurance, licensing and other supply costs through bulk purchases;
- Minimizes administrative and operating costs by sharing office, control center and maintenance facilities;
- Increases service capacity by pooling vehicles, equipment, and facilities;
- Expands service area and provides expanded hours of service;
- Reduces passenger travel and wait time;
- Improves productivity and may reduce operating costs;
- Reduces total number of back-up vehicles required;
- May reduce labor costs through staff sharing;
- Improves development and efficient use of existing technical and transportation expertise and assistance; and
- Provides a consolidated clearinghouse for disseminating transportation information throughout the community.

(B) Obstacles to Coordination

Despite the many potential benefits, and although coordination is mentioned in most of the federal statutes regulating social service agencies, the range and character of these statutes vary considerably. In addition, although a government study (General Accounting Office, Reference 106) was unable to identify any express federal statutory or regulatory restrictions specifically prohibiting coordination, impediments can be found at almost every government level, and within private and non-profit agencies as well. The following list identifies many of the barriers that have confronted local communities in their attempts to coordinate transportation programs and services:

- Confusion and lack of information at all government levels of the extent to which individually-funded projects may share and coordinate their transportation resources;
- Inconsistent federal, state, and local regulations, interpretations, or guidelines (e.g., UMTA mandates "fully accessible" public transit systems, while granting increased funding for specialized transit services);

4.2.2

- Lack of existing local operators;
- Conflicts with existing public or private transportation providers (e.g., franchise restrictions);
- Lack of concern or ability among existing operators to meet target market needs;
- Absence of strong local leadership in administration, managerial and political areas;
- Restricted and uncoordinated funding sources (see Section 4.2.3 for additional funding information);
- User eligibility restrictions (e.g., age, income, health or physical condition and location);
- Provider eligibility restrictions (e.g., public, private-for-profit, private-non-profit, etc.);
- Inconsistencies in methods of recordkeeping, data management and monitoring requirements (e.g., strict individual client accountability versus overall program breakdown identifying total transit costs);
- Rigid or incompatible transit schedules and routes;
- Difficulties in determining vehicle model and fleet size as well as demand for service;
- Differences in staff size, experience, and costs (e.g., volunteer, part-time, or unionized labor); and
- Local "turf" protection--Experience shows that individual agencies feel their programs and clients are the "most important" and any coordination of services will subjugate their needs. Some agencies fear that emergency or unplanned client needs cannot be adequately met.

4.2.3
for funding
restrictions or
requirements

(C) Planning for Coordinated Service

Improper planning can lead to inefficient services, low levels of vehicle utilization, and hence relatively high costs per passenger. Since many small social service agencies do not have planning experience or technical transportation backgrounds, it may be necessary for them to seek expertise from local and regional planning and transportation agencies or existing transit and paratransit operators. The Regional Planning Agency (RPA) may be particularly helpful, as it has detailed information about the area, with a skilled staff who provide guidance and review plans and applications for federal assistance.

Experience has demonstrated the importance of strong local leadership, as well as government support, in overcoming the variety of obstacles to coordination, and especially in helping to reorient agency-specific transportation programs to broader-based yet still specialized transportation services. Separating transit services from the total program was identified by many agencies as a difficult step to make.

The special needs of targeted groups must be identified, and representatives of these groups should be consulted. The special needs of the elderly are often quite difference from those of non-ambulatory and youth groups. The advisory committee should thus take the needs of these individual groups into account. For example, the hours of needed service may vary considerably; several agencies may have early morning and late afternoon peak demands, while others have high midday travel demands (e.g., the elderly nutrition programs). By taking advantage of these time differentials,

4.2.2

total vehicle and driver productivity can be improved. Remain sensitive, however, to "home turf interests," so that no program or service is slighted.

If local needs among individual systems are similar, focus the coordination efforts toward the demand for specific travel patterns. For example, since existing target market services show that the largest number of non-social service agency trips are made for medical purposes, initial service might be oriented toward the local hospital or medical facilities.

(D) Options for Coordinating Services

<u>(i) Operator Options</u>. In addition to the guidance provided in Part II, Section 3.2.1, organizational factors take on additional importance when coordinating target market services. In general, the travel demands, available supply and local conditions, weighed against relative costs, provide the basis for selecting the preferred option. Many of the existing social service providers would like to get out of the transportation business and focus more attention on their primary program activities. Unfortunately, recent experience also shows that many transit operators resist special transit service involvement because of the extra demands and time-consuming requirements that lower productivity and push operating costs higher. Therefore, most operators need additional financial incentives to consider a target market program.

While contracts with taxicab operators may also be possible for some services, the majority of taxi companies use standard vehicles that are not accessible to targeted wheelchair users.

3.2.1
for selecting
technical support

Recent state involvement has also yielded some excellent examples of public consolidation of disparate funding sources to achieve cost-effective coordinated transportation programs and services. The Delaware Authority for Specialized Transit (DAST) has provided statewide paratransit services through purchase-of-service contracts; local governments, private and non-profit organizations purchase transportation services for their targeted groups at a lower cost than was previously possible.

In Missouri, target market paratransit service (OATS) is a statewide service organization which began as a cooperative but later switched to become a not-for-profit corporation in order to take advantage of statutory regulations. As a result of this experience, the general manager of this system suggests paying special attention to the tax benefits and funding requirements when deciding what arrangement is best.

Smaller states (e.g., Delaware and Rhode Island) may not have the additional geographic and political difficulties of larger states. Nevertheless, in West Virginia and Missouri, successful elderly and handicapped transportation providers were developed by focusing primarily on rural areas.

<u>(ii) Guidance</u>. An estimate of existing and projected unit and total costs per passenger or average trip can enable each coordinating agency to make comparative in-house cost assessments. To achieve better overall financial performance and to increase the quality of the service, initially contact those agencies which have an excess capacity of vehicles, facilities, and staff. In addition, identify the overlapping and duplication of services. A note of warning: Exercise caution when developing cost estimates. Coordination of fragmented services is a time-consuming venture, and

4.2.2
4.2.3

initial administrative and accounting costs may be high. True costs are also often masked by substantial volunteer time and by the inclusion of transportation expenses in the general program's operating budget. While only a limited number of sponsored public efforts are documented, local coordination can reduce costs and provide better services. In Chattanooga, Tennessee, 40 service providers have managed to lower their average cost per passenger-mile from $2.93 to $.61 by pooling their resources into a single radio-dispatched pick-up system (Reference 133).

It may be useful to develop a relatively simple management information and accounting system to provide the necessary cost and operating data required to monitor and evaluate the transit service. But keep it simple--each agency will still maintain its own accounting system.

4.2.3 Funding

A variety of funding sources at the state, local and federal level are available to support the special needs of target market services. Unfortunately, access to these sources is blocked by numerous restrictions, making the pooling or sharing of these resources by more than a single recipient extremely difficult (refer to Section 4.2.2 on Coordination). The various government agencies, with their own planning restrictions and separate funding regulations, can appear confusing to even the most experienced funding coordinator. Some of the most commonly confronted funding problems are listed in the exhibit.

PROBLEM AREAS IN FUNDING FOR TARGET MARKET SERVICES

- Competition with general market transit services for limited federal, state and local funds.
- Scarcity of local-matching funding programs.
- Inconsistency in local-matching percentage requirements.
- Conflicts in funding schedules.
- Lack of continuity in funding programs.
- Tight restrictions on use and integration of funds.

(Source: SYSTAN)

4.2.2 (B)
Obstacles to
Coordination

(A) Local Funding

Most target market demand-responsive transit services depend heavily on local funding. Of twenty-nine target market systems surveyed, most relied on more than one source for support, and 65% received funding from the local level (see exhibit).

Local public revenues for target market transit can come from:

- Property tax;
- Motor vehicle tax;
- Gasoline sales tax;
- Tax on gross receipts of parking lots;
- Sales and use tax;
- Highway fund allocations;
- Cigarette tax fund;
- Business license tax;
- Income tax;
- Public utilities tax;
- Payroll or wage tax; and
- Special transit district tax.

(Reference 141)

FUNDING SOURCES FOR

29 TARGET MARKET SERVICES

Funding Source	Number of Systems	Percent
Federal	19	65.5
State	13	44.8
City	19	65.5
County	4	13.8
Special District	3	10.3
Local Organization	7	24.1
Total:	65	224.0%

*Average of 2.2 sources per system.

(Source: SYSTAN)

4.2.3

In addition, financial support can originate from such private sources as:

- United Fund;
- American Red Cross;
- American Cancer Society;
- Easter Seal Society;
- Area Agency on Aging;
- Muscular Dystrophy;
- United Cerebral Palsy;
- Local religious groups; and
- Private industrial or commercial concerns.

As examples of innovative funding arrangements, exclusive commuter and "shopper's special" transit services have negotiated with private business firms and shopping centers to defray part of their operating costs. Business and activity centers may be willing to lend support to a transit service that will attract more people to their area.

(B) State Funding Sources

In addition to the state funding programs available to general market services (see Part II, Section 2.2.5),

2.2.5
Funding Sources

SUMMARY OF GUIDELINES FOR THE EVALUATION AND SELECTION OF PROJECTS BY NYSDOT

Criterion 1	Degree of ability of organization to meet needs of elderly and handicapped
	Agencies funded by Title III or VII of Older Americans Act
For Elderly Organizations	Senior Citizen Agencies providing generel services
	Generel Purpose Agencies serving more then senior citizens purpose
	Agencies not provided for above or who have inefficiently used funds or vehicles in the past
	Negetive comments from A-95 Review Process
	Agencies serving the non-ambulatory
	Agencies serving the semi-embuletory
Hendicapped Organizetions	Agencies with hendiceps not restricting mobility
	Agencies heving used funds or vehicles inefficiently in the past
Criterion 2	Appropriateness of Applicents Stetement to provide designated service
Criterion 3	Commitment to Providing Transportetion Services to Clientele groups
	New vehicles to replece old unsafe vehicles
	New vehicles to expand service
	New vehicles for generel comfort or new services
	Replacement of vehicles for no apparent reason
Criterion 4	Ability of Agencies to Coordinate to provide efficiencies in cost and equipment
	Agencies documenting multiple agency support of operating costs
	Agencies indiceting multiple perticipation in use of equipment but not in costs
	Passive support from other agencies or letters of endorsement
	No support from other agencies
Criterion 5	Consistency or supplementetion of existing government sponsored programs
	Agencies directly complementing other programs
	Agencies not complementing other programs
	Agencies inconsistent with area plans but still worthwhile
	Agencies totally inconsistent with government policies and programs

(Source: DOT, TSC, Reference 147)

many states have budgeted monies for the exclusive use of target market services. Funds have been set aside through:

- Direct budget allocations for various social services;
- Special funds;
- Bond issues;
- Lotteries; and
- Sales, gas, property, income, or special taxes.

In Michigan, transit services for the elderly and handicapped receive funds earmarked for purchasing vehicles, in addition to a maximum of $10,000 per vehicle for operating during the first year. The following year, up to $5,000 per vehicle is available from the state as an incentive for communities to continue the services with other, additional funds.

Although many states provide continuing aid for their target market services, additional restrictions on the existing programs are often imposed. For example, in California, taxicabs are not allowed to service the federal Title XIX (Medicaid) program, whereas other states do not prohibit taxis from participating in such specialized services.

Coordination and selection of potential applicants for funding under UMTA's elderly and handicapped Section 16(b)(2) program is a state responsibility. The exhibit summarizes the five criteria used by New York State's Department of Transportation for evaluating and selecting projects to receive such funding.

UMTA 16(b)(2) regulations set the following rules for all private, non-profit organizations applying for funds:

> ...Projects funded by UMTA under Section 16(b)(2) may be identified as deriving from local special efforts to meet the needs of wheelchair users and semiambulatory persons only to the extent that the following four conditions are met: (1) the service and vehicles serve wheelchair users and semiambulatory persons; (2) the service meets a priority need identified in this planning process; (3) the service is not restricted to a particularized organizational or institutional clientele; and (4) any fares charged are comparable to those which are charged on standard transit buses for trips of similar length.

In other types of federal funding programs which are not earmarked for target markets (see Section 2.2.5), eligibility requires "special efforts in planning public mass transportation facilities and services that can be utilized by elderly and handicapped persons." (Reference 149) The policy does not dictate what constitutes special efforts. Recently proposed rules for implementing Section 504 regulations in DOT requires that transit programs and systems be accessible to or useable by handicapped persons; each part of the service need not be accessible. Nevertheless, at the time of this writing there is ongoing disagreement within communities over how the objective of accessibility and these proposed requirements can be attained. Federal policy may be changing as a result of the experiences being generated.

P
2.2.5
Funding Sources

4.2.3

(C) Federal Funding Sources

Although coordinated planning of transportation services and resources is a stated goal in most federal statutory regulations, the variety of funding program characteristics and requirements poses a barrier to coordination.

For example, advance planning requirements for transit projects can range from detailed descriptions of how program funds will be used (e.g., Social Security Title XIX and XX) to brief project summaries on the grant application (e.g., Head Start). In some cases, grantees must produce their own transportation plans (e.g., Older American Title III and VII); other programs require outside agency plans (e.g., DOT and HUD)(Reference 144). The funding exhibit is included as useful guidance to the major federal funding sources available for target market services. Services relying on existing federal funding sources should consider checking other programs that have similar provider, user, trip purpose, services, and area restrictions.

As coordination efforts continue, funding programs should eventually be more easily intermarried to meet community target market needs. For example, the Administration on Aging (AOA) and UMTA recently developed a working agreement to encourage agency transportation service coordination, and the Office of Human Development Services (OHDS) in HEW has selected five demonstration sites to sponsor five different coordinated transportation systems.

MAJOR FEDERAL FUNDING SOURCES FOR TARGET MARKET PARATRANSIT SERVICES

Federal Department Statute Title & Section	Description	Provides Transport for	Provider Eligibility/ Administering Agency	Target Market	User Eligibility Restrictions	Area Coverage	Capital Purchase	Comments
Department of Transportation (DOT)								
Urban Mass Transportation Assistance Act of 1964, as amended Title III, Section 16(b)(2)	Social service capital grants	Special transportation needs	Private & non-profit agencies	Elderly & handicapped	UMTA elderly & handicapped criteria	Urban areas over 5,000 population	Allowed	Intended for areas where existing or proposed public and private services were not adequate
(FOR OTHER SECTIONS OF UMTA FUNDING NOT EXCLUSIVELY EARMARKED FOR TARGET MARKETS, SEE SECTION 2.2.5.)								
Federal Highway Act of 1973 Section 147	Rural highway demonstrations	Public in rural & small urban areas	Public or non-profit public purpose agencies in communities with less than 5,000 population	Elderly & handicapped	FHWA elderly & handicapped criteria	Towns of less than 5,000 population	Allowed; operating costs limited to one-third of total grant	Projects demonstrating innovative service types, coordination, funding, management, etc. (Rolling stock must include one vehicle to accommodate wheelchair users.)
Department of Agriculture								
Consolidated Farm and Rural Development Act of 1972 Title I, Section 118A	Improve rural economic & living conditions	Essential community facilities	Individuals, public & private organizations; Indian tribes	General public use	None	Up to 10,000 population	Allowed	Two or more areas may be grouped together to provide an essential service that one area alone could not support.
Department of Housing and Urban Development (HUD)								
Housing & Community Development Act of 1974 Entitlement Grants	Community development program for social services	General population for special projects	General unit of local government; urban community >50,000 population	Low-income, elderly and handicapped	Community decision	Community	Allowed	Funds may be used to support capital, operating, or administrative transportation costs, but must be integral part of total community development program.
Department of Health, Education and Welfare (HEW)								
Social Security Act of 1935, as amended								
Title XIX	Medicaid	Medical purposes	Single state agency (usually Dept. of Welfare)	Low-income, elderly, blind, disabled	SSI eligiblity criteria or more restrictive criteria at state option	State	Prohibited	Federal financial reimbursement available for transportation of ambulance, taxicab, privately-owned vehicle, or other "appropriate" means.
Title XX	Services to low-income, aged, blind and disabled	Defined services, medical services and essential shopping		Low-income, elderly, blind, disabled	At least age 60, SSI recipient or or applicant	State	Allowed	Replaces funds formerly administered through Title VIA and VI. Must be included in state plan.

Federal Department Statute Title and Section	Description	Provides Transport for	Provider Eligibility/ Administering Agency	Target Market	User Eligibility Restrictions	Area Coverage	Capital Purchase	Comments
Older Americans Act of 1965, as amended Title VII	Elderly nutrition	Nutrition sites	Any public or private agency-single recipient in project area	Elderly	At least 60+ & spouses, "limited mobility" status	Urban or rural	Allowed	Purchase of vehicles and special equipment, client and staff reimbursement, and services allowed.
Title III, Section 308	Model projects	Model projects to expand social services	State Agency on Aging; designates public or non-profit organization as the Area Agency on Aging	Physically or mentally impaired elderly	None	Varies	Prohibited	AoA encourages capital purchase by coordinating with DOT funds.
Title III, all sections except 308	Programs on Aging	Access to social services		Elderly	Dept. of Commerce criteria	Social service areas	Discouraged	Client and staff transportation reimbursement; and purchase of service contracts
Public Health Service Act of 1944, as amended Title III, Section 314(d)	Comprehensive health services	Broad health services	State health and/or mental health authorities	General population with health needs, especially "high-risk" groups	None	Community	Allowed with state approval	Must have state plan; formula matching depends on state's per capital income
Mental Retardation Facilities and Community Mental Health Centers Construction Act of 1963, as amended Title II	Mental health centers	Mental health services	State administrator, usually Dept. of Health; local public or private non-profit agencies	Mental health clients in service area	None	Areas of 75,000-200,000 population	Allowed	Proposed merger with health care funding
Vocational Rehabilitation Act of 1973	Vocational rehabilitation facilities and services	Any vocational rehabilitation services (including medical)	State vocational rehabilitation agencies & public or non-profit organizations (e.g., Goodwill)	Vocational rehabiliation clients	Unemployed, handicapped but employable	State	Allowed but not encouraged	Transportation items must be included in state plan. Purchase of special equipment, services and staff and client reimbursement allowed.

Federal Department Statute Title & Section	Description	Provides Transport for	Provider Eligibility/ Administering Agency	Target Market	User Eligibility Requirements	Area Coverage	Capital Purchase	Comments
Community Service Administration (CSA)	Economic Opportunity & Community Partnership Act of 1974:							
Title II	Community Action Programs (CAP)		State, city or or group of communities within minimum 50,000 pop.; Indian reservation; designated by gov't agency with jurisdiction over entire area	Poor	Low-income individuals & families	Community Action Agency (CAA) jurisdiction		CAA must document transportation need in CAP.
Head Start	Child development	Health, nutritional, educational & social service programs	Public or private non-profit organization (many are CAA's)	Low-income pre-school children	Low-income children & families	Community	Allowed	Local Head Start agency can own & operate own vehicles; transportation costs not required as separate line item
Department of Labor (DOL)	Comprehensive Employment and Labor Act of 1973							
CETA Titles II, III, VI	Employment programs	General population	Public or private non-profit agencies; private for profit organizations not eligible	Under- and unemployed youth	DOL unemployment criteria		Possible	Existing general market and target market DRT services have used CETA funds for staffing
ACTION								
Domestic Volunteer Service Act of 1973								
Title II, Section 201	Retired Senior Volunteer Program (RSVP)	Volunteer stations	Community service organizations	Elderly	At least 60, retired, able to work	Community	Allowed with prior approval	Volunteers used in existing target market paratransit services; sensitive to elderly needs
Title II, Section 221(a)	Foster Grandparents Program	Low-income elderly and children with special problems		Elderly	At least 60, OEO, retired, able to help children	One or more communities	Allowed with prior approval	Possible 100% federal funding

(Sources: Developed from References 60, 106, 124 and 141. Refer to Reference 124 for complete inventory of programs and funding sources available.)

4.2.4 Institutional Issues

Most of the available documentation of those institutional issues that are unique to paratransit pertains to special services for the elderly and handicapped. Many of these services are funded through federal assistance, and have met specific requirements to gain funding approval. Certain institutional issues have been addressed in other sections (see Section 4.2.2 on coordination concerns and Section 4.2.3 on funding issues). This section addresses four of the five issues identified in the Institute for Public Administration's Transportation Planning Handbook for the Elderly (Reference 56) as the most common institutional problems encountered in establishing transportation systems for the elderly:

- Franchise law conflicts;
- Labor union agreements;
- Insurance rating systems;
- Vehicle registration and safety requirements (discussed in Section 4.2.8); and
- Restrictions on the use of school buses.

(A) Franchise Conflicts

Two possible franchise problems are:

- Competition with an existing operation; and
- The lengthy process of obtaining a franchise.

Specialized transportation for the elderly and handicapped may be viewed by existing transit operators as competition drawing ridership away from their own systems. It becomes important to examine existing franchises, certificates or licenses for the scope of operations authorized. Operations within a state are regulated by a state public services or utilities agency, which may issue a franchise to a common carrier or a certificate of convenience and necessity. This certificate authorizes the carriers, but implies no monopoly rights. A franchise gives the carrier the right to do business within a certain area. These rights may be either non-exclusive or exclusive. (If exclusive, no similar service is permitted.)

Suits have been filed over perceived conflicts in operating rights. In Tucson, Arizona, a city-sponsored elderly and handicapped service was sued by a private firm (Handi-Car, Inc.) which held an exclusive franchise for handicapped service. Handi-Car secured an injunction stopping the city-operated handicapped service.

Two suggested ways around franchise problems are to:

- Avoid the need to obtain a franchise by offering free services, thus exempting the system from regulation (this approach depends on local regulations); and
- Integrate the system with existing bus or taxi services. (Reference 56)

To clarify regulatory and legal constraints, the accompanying exhibit lists questions (from the Iowa City, Iowa System for the Elderly) aimed at soliciting responses from the regulatory body governing the proposed system (Reference 50).

(B) Labor

The main labor issues associated with target market transit operations concern:

4.2.2 Coordination
4.2.3 Funding
4.2.8 Special Equipment

LEGAL QUESTIONS CONCERNING OPERATIONS,
REGULATION AND FUNDING IN IOWA CITY, IOWA

- Which federal, state, county, and city laws, ordinances, franchises, guidelines and policies are relevant to the implementation and operation of the transportation service?
- Which statutes, etc. are related to the administration of the system by an (a) Non-Profit Organization?
  - (1) Private, e.g., Systems Unlimited, Inc. of Iowa City
  - (2) Public
  - (b) County Board of Supervisors?
- Which are related to the transportation system itself, i.e.,

  Drivers -- training, special licence, etc.
  Vehicles -- equipment, licensing, full tax, liability
  Routes -- schedules
  Level of Service -- capacity, safety
  Users -- may handicapped ride the system? If so, are there additional guidelines that must be met? May other than elderly use the bus? If so, what are the legal implications of that? May other organizations, such as schools, churches, etc. rent the vehicle for excursions? If so, what legal foundations are relevant? May the vehicle be used by non-elderly?
- It might also deliver groceries, medical supplies, etc. and home-care people from the Regional Medical Program?
- Oispatching -- Are there legal precedents, licenses, etc. related to (a) telephone dispatching, (b) two-way multi-band raoios on the vehicles?
- Ooes maintenance of the venicle titles by the State Agency on Aging legally affect the administration of the system by county organizations?
- Does requirement of a membership to ride affect the legal status of the system and its operation? If memberships are not required in order to ride the system, and higher fares are charged, does this affect the system's legal status?
- Does the concept of 'cooperative' relate to the service? If so, what are the associated advantages and disadvantages of that status?
- From what people and agencies is it necessary to obtain permission (or a license) in order to operate the proposed service?
- May revenue sharing funds be spent on the proposed system by City and/or County authorities?
- Who may set up sub-contracts between the Area X Agency on Aging and county organizations, and what should be the tenets of that contract?
  - (a) May the system, which is county-wide, provide services within cities where there are transportation alternatives such as transit, taxi, other? If so, may memberships be sold to those people?
  - (b) May the system cross county lines? May it serve people in cities already served by Greyhound or Missouri Transit?
- What should be known about liability and accidents, both inside the vehicle and between the vehicle and other property, vehicles, or persons?
- If this mini-bus competes with existing transportation, are there legal implications which should be considered? If so, which ones?
- What other recommendations do you have regarding such a system?
- What agencies and people represent a sufficient list that should be contacted to proceed in a legal and rational manner with the implementation and operating of the proposed system?
- How may county and city systems legally interface?
- How may sheriff and mini-bus dispatching operation legally be coordinated?

(Source: McKelvey, Reference 50)

4.2.4

(1) Labor concurrence for federal assistance to private operators under Section 3 funding; and

(2) Work rules.

(i) Federal Assistance. Section 13(c) of the Urban Mass Transportation Act requires Department of Labor concurrence on grant applications. The Department of Labor, in turn, requires local union approval (see SCRAPS Section 6.1). This procedure raises the following issues (Reference 94):

- If a specialized transportation system operates in the same general service area as a public unionized transit system and plans to use non-union drivers, the union representing the transit employees will probably not sign a 13(c) agreement, thus blocking UMTA funds for capital and operating assistance.

- If a specialized service is to be operated for a transit authority, an agreement will still be needed with the union.

- If any taxi drivers are union members, or if they claim their employment is affected, they can petition the Department of Labor to deny the request for federal funds.

Funds solicited under Section 16(b)(2) for use by private, non-profit operators are not governed by 13(c) provisions.

(ii) Work Rules. The nature of the tasks to be performed by union labor in operating a specialized trans-

Syracuse, New York

SCRAPS Section 6.1
Department of Labor
Guidelines

portation system is another major labor issue. Work rule considerations should include:

- Specific additional services performed by drivers or attendants (such as lifting handicapped travelers or helping them to board and alight) not currently covered by the labor contract;
- The effect of additional job requirements on labor rates; and
- The effect of the new services on contract items such as total hours operated and schedule provisions.

In Worchester, Massachusetts, the transportation service for the elderly experienced strained labor relations when union drivers insisted that escorts be on-board to assist passengers.

(C) Insurance

Insurance issues are influenced by the newness of specialized transportation projects and by fears that increased elderly and handicapped ridership may result in more claims and increased liability insurance. The majority of the accident claims filed in Cleveland were filed by elderly or handicapped persons. More information is needed to ascertain the accident and claim experience of the elderly and handicapped in specialized services:

> "Special insurance coverages may be needed to protect both the rider and the transport operator from hazard or lawsuit. Investigations should be made to identify and describe new or special risks and additional insurance coverages needed to protect against these risks, such as:
>
> - Liability arising from permitting the driver to leave the controls to assist handicapped persons in boarding or alighting;
> - Personal injuries of the handicapped arising from the service provided; and
> - Special coverage for accidents resulting from acceleration or braking of the vehicle." (Reference 132)

These issues should be discussed both with insurance companies while shopping for insurance rates and with union labor concerning work rules. In a Missouri system (OATS), the insurance rates were lowered after system experience showed few accidents and adherence to strict driver selection procedures.

Insurance issues arising from the use of volunteer drivers are shown in the following exhibit presented as a list of questions to clarify insurance liability and responsibility (Reference 50).

(D) Use of School Buses

School buses have been considered an attractive option for transit service, since they remain idle between trips to and from school. However, state laws restrict their use. The accompanying exhibit indicates the status of these state laws.

During the planning process, specific state laws should be checked, since there may be additional factors to be considered regarding the operation of special services for the elderly and handicapped.

4.2.4

Other problems encountered with the use of school buses include:

- Ad hoc during-school-hours demands by the school district;
- Difficulty obtaining drivers;
- Means of cost-sharing with the school district;
- Insurance for non-school purposes;
- Safety requirements (color, lights, handrails, etc.);
- Comfort factor for adults and the elderly who must sit in spaces designed for children;
- High steps that make entry difficult for the elderly and handicapped; and
- State legal restrictions.

INSURANCE AND VOLUNTEER DRIVERS

Setting: A senior citizens' services group uses volunteer drivers, who are reimbursed at a set rate per mile, to transport the elderly to the lunch sites. The following questions are those of both liability and responsibility.

Liability: It is generally agreed that a driver who transports others for no fee would be covered by his own personal auto insurance policy, even though he is reimbursed for his mileage.

Questions: If an accident occurs, under what circumstances can he and his company be sued for a personal injury or wrongful death by other third parties and by passenger guests? What is the difference between liability of a driver to his passengers for negligence as opposed to his liability in case of an accident with a non-insured negligent third party? Is there liability in an accident occurring as a person enters or leaves the auto or is helped to or from a building by the driver? How much liability should he carry? Should it be increased once he begins to transport others on a regular (volunteer) basis? ...assume the extent of necessary liability insurance relates to the extent of his own property (his solvancy). Is this correct? Are there limits on a suit of this type?

The project has purchased an auto liability insurance policy. This is to cover the project as an entity in case it were named as a party defendant in a personal injury suit or wrongful death action and to cover staff members if involved in an accident while transporting elderly program participants (which they occassionally do). This was purchased on the advice of an insurance representative.

Questions: Can a Title VII program as a federal agency be sued by a private citizen? How extensive should the liability coverage be? Is it while riding or from door to door?

Responsibility: Although the liability of the agency and its staff may be minimal under the law, ...feel the agency's responsibility in this kind of a system is great. The agency has solicited the services of these citizens and in many cases provided the link between the drivers and the riders.

Questions: Is there some way the agency can protect its elderly drivers from a suit? Can passengers be requested to sign some sort of release that would be binding in case of an accident? Could there be any kind of an agreement so that the program would assume liability rather than the driver? Is this desirable? What are the insurance facts of which each volunteer driver should be apprised by the agency before he begins to drive? What standards should be developed in selection of volunteer drivers?

Of all the above is there a difference between law and policy, i.e., mandate or desirablility?

(Source: McKelvey, Reference 50)

SUMMARY OF STATE STATUTES AND REGULATIONS ON USE OF SCHOOL BUSES FOR NON-SCHOOL USES AS OF SEPTEMBER, 1974

Status of State	Number	States
1. Have statutes explicitly allowing use of school buses by elderly for transport.	11	Colorado, Idaho, Indiana, Kansas, Iowa, Michigan, Nebraska, New York, South Dakota, Washington, West Virginia
2. Have statutes explicitly allowing more general uses of school buses in which the elderly could participate.	8	Kentucky, Maine, Minnesota, Montana, Nevada, New Mexico, Oregon, Virginia
3. Leave use decision as local option (either through absence of any state law or broad interpretation of law).	13	Alabama, Alaska, Arizona, Arkansas, California, Connecticut, Maryland, New Hampshire, North Dakots, Tennessee, Utah, Vermont, Wyoming
4. Prohibits use of school buses for non-school uses (either through restrictive statute or narrow interpretation).	14	Florida, Georgia, Illinois, Louisiana, Missouri, Mississippi, North Carolina, New Jersey, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Wisconsin
5. States primarily served by privately-owned school bus fleet on which there are some restrictions on availability of vehicles.	5*	Hawaii, Massachusetts, District of Columbia, Delaware, Rhode Island
TOTAL	51*	

* Includes the District of Columbia
(Source: Revis, Reference 141)

4.2.5 Estimating the Size of the Target Market Population

Estimates of the size of the target market population can come from any of three sources:

(1) Extrapolation from census materials or other secondary sources;

(2) Information gathered from social service agencies; and

(3) Advance surveys of the target market population.

The first two of these sources typically provide rough estimates suitable for use in the planning stage of system development. The third source, advance surveys, may generate more detailed information suitable for system design work. The use of these three approaches in estimating the size and travel preferences of the elderly and handicapped population is discussed in this subsection.

(A) Extrapolating From Existing Sources

(i) Estimating the Number of Elderly. Estimates of the number of elderly residents within a neighborhood, area, or urban region may be obtained directly from the U.S. Census of Population.

(ii) Estimating the Number of Transportation-Handicapped. It is somewhat more difficult to determine the number of handicapped at a comparable level of detail. In recent years, a number of substantial research efforts have attempted to develop estimates of the number of transportation-handicapped residents in different parts of the United States. Studies have been conducted by UMTA and TSC (Reference 148), the Northeastern Illinois Planning Commission (Reference 138), the State of Massachusetts (Reference 145), the Carnegie-Mellon Transportation Research Institute (Reference 146), Abt Associates (Reference 122), and the Capitol District Transportation Committee (Reference 125). Crain and Associates (Reference 129) compared four of the major studies, and found shortcomings in each of the methodologies. A summary table from the Crain report comparing the studies of UMTA/TSC, Northeastern Illinois, Massachusetts, and Carnegie-Mellon is shown in the exhibit. These four procedures provide estimates of the number of urban transportation-handicapped in 1970 ranging from 6 to 9 million, or 4.2% to 6.4% of the urban population. Upon reviewing the same four reports, Abt Associates developed a general classification scheme and estimating approach which could be used to estimate the size of the transportation-handicapped market in any SMSA (Reference 122). This approach resulted in an estimate that 3.8% of the 1975 metropolitan area population could be classified as transportation-handicapped.

The Abt approach is based on mobility limitations and related to functional requirements as addressed in the National Health Survey (Reference 139). The approach takes into account differences in the incidence of mobility limitation among regions and between the population as a whole and the metropolitan population. Incidence rates for mobility limitations due to chronic conditions by age and region are presented in the following table. These rates, which have been developed for the non-institutionalized population, can be combined with nationwide incidence rates for the institutionalized population and local census data to produce crude estimates of the transportation-handicapped population of any SMSA. Once estimates of the institutionalized portion of the population have been sub-

AVAILABLE ESTIMATES OF THE SIZE OF THE TRANSPORTATION HANDICAPPED (TH) POPULATION

SOURCE	UMTA/TSC*	MICHAELS-WEILER**	TEIXEIRA+	TRANSPORTATION RESEARCH INSTITUTE++
Classification Scheme	Medical conditions, use of special aids, mobility limitations plus acute conditions plus institutionalized	Medical conditions, use of special aids, mobility limitations, functional disabilities	Medical conditions, use of special aids, mobility limitations and acute conditions and institutionalized	Mobility limitations plus acute conditions
Data Base	National Health Survey, Social Security Survey, Census Data	Local survey	UMTA/TSC, panel of local experts	National Health Survey
Advantages	Differentiates those who use transit with difficulty and those who cannot use transit; elderly vs. nonelderly	Relates mobility limitations and functional disabilities; defines three categories of TH: little, moderate, and severe (based on mobility limitations and use of aids); also indicates those probably unable to use transit	Defines those who use transit with moderate difficulty, use transit with severe difficulty, and unable to use transit	Uses national data, consistent logic, and mutually exclusive categories
Disadvantages	Based on secondary sources, faulty logic; double-counting; nonmutually exclusive categories; not clear if young are included	Possibly biased survey responses; not clear how incidence rates of TH for total population are derived from incidence by medical condition; ignores young, acutely disabled, institutionalized	Based on UMTA/TSC estimates; overestimates severity of handicaps for a number of conditions, as compared to survey results	Based on secondary sources, overestimates incidence of acute conditions; ignores institutionalized; no attempt to differentiate TH by severity of handicap
Total Number of Urban TH (1970) (Approximated)	9,225,000	5,999,000	9,225,000	6,138,000

*Urban Mass Transportation Adminstration and Transportation Systems Center, The Handicapped and Elderly Market for Urban Mass Transit

**Michaels, R.M. & N.S. Weiler, Transportation Needs of the Mobility Limited.

+Teixeira, Diogo, The Links Project: A State-Wide Elderly Transportation Program.

++Transportation Research Institute, Latent Demands for Urban Transportation.

(Source: Crain, Reference 129)

4.2.5

tracted from each age grouping, the calculation procedure is straightforward. The accompanying flow diagram illustrates the procedure for the U.S. as a whole. Examples of the calculation procedure for individual SMSA's may be found in References 122 and 129.

INCIDENCE OF MOBILITY LIMITATIONS DUE TO CHRONIC CONDITIONS BY AGE, REGION, AND MOBILITY-LIMITATION CATEGORY: SMSAs (NONINSTITUTIONAL)

	Incidence of Mobility Limitation (Number Mobility Limited/1000 Population)					
	Use Transit With Difficulty		Cannot Use Transit			
Age and Region	Has Trouble	Uses Other Aids	Uses Other Aids	Needs Help	Uses Wheelchair	Confined to House
North East						
Under 18	0.90	0.15	0.08	0.45	0.23	0.45
18 to 64	8.44	1.46	0.34	1.31	1.31	5.48
65 & Over	38.44	18.33	13.06	14.73	9.61	61.50
North Central						
Under 18	0.71	0.11	0.07	0.53	0.35	0.35
18 to 64	9.31	1.29	0.75	1.26	1.16	3.78
65 & Over	44.77	20.84	14.85	16.23	10.89	38.11
South						
Under 18	1.26	0.10	0.06	0.78	0.47	0.94
18 to 64	12.96	1.91	1.10	1.76	1.67	7.11
65 & Over	67.50	21.62	15.40	16.88	11.43	66.41
West						
Under 18	0.84	0.18	0.10	0.84	0.56	0.28
18 to 64	9.52	1.39	0.81	1.32	1.32	5.42
65 & Over	40.90	20.12	14.33	16.15	10.76	40.90

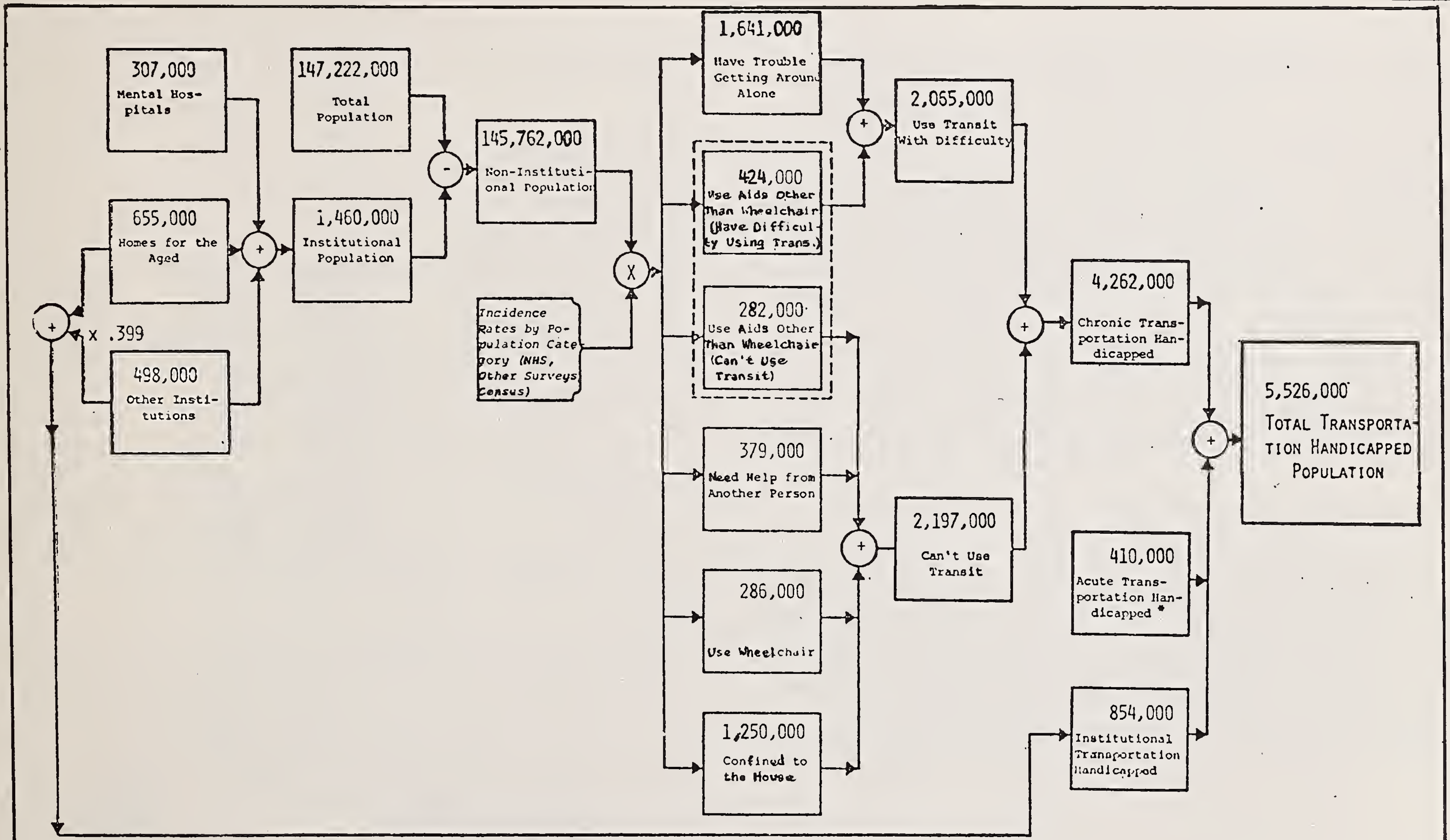
(Source: Crain, Reference 129)

PERCENTAGE DISTRIBUTION OF U.S. INSTITUTIONALIZED POPULATION, BY AGE AND TYPE OF INSTITUTION

	Type of Institution		
Age	Mental Hospital	Home for The Aged	Other Institution
Under 18	4.40%	0.26%	28.00%
18 to 64	68.99	13.94	64.39
65 & Over	26.61	35.80	7.61
TOTAL	100.00	100.00	100.00

Source: U.S. Bureau of the Census, Census of the Population: 1970, Detailed Characteristics.

* Regions are defined as follows by the Census: North East - Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania; North Central - Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; South - Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas; and West - Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, and Hawaii.



Estimation Procedure for Urban Transportation Handicapped (TH) Population: 1975

* Estimated as Noninstitutional Population x Incidence Rate.

(Source: Abt Associates, Reference 122)

(iii) Estimating the Number of Elderly and Handicapped. The Abt estimating procedure described above, like the other referenced procedures for estimating the number of transportation handicapped, rests on a number of heroic assumptions. Crain confirms, therefore, that "...the results should be viewed with some skepticism." Nonetheless, the procedure provides a rough first approximation of the number of transportation-handicapped in any given SMSA. The procedure has the added advantage that estimates are produced by age category. Thus, the proportion of elderly among the transportation-handicapped is readily calculated. In developing estimates of the total market size for systems directed at the elderly and the handicapped, this proportion should be subtracted from the total elderly population. Since the elderly comprise a substantial percentage of the transportation handicapped (see accompanying breakdown for total U.S. figures), this adjustment must be made to avoid double-counting.

(B) Gathering Information From Social Service Agencies

Rough estimates of the size of the target market population should be augmented with more detailed information regarding the travel patterns and transportation needs of members of that population. Social service and welfare agencies, along with hospitals, clinics, and senior citizen centers, are the primary sources of this information. The accompanying exhibit provides an illustrative list of the types of agencies that might be canvassed, along with the data that might be available from these agencies.

HANDICAPPED WITH TRANSPORTATION DYSFUNCTIONS,[1] U.S., 1970

Handicap Class	Elderly Handicapped	Nonelderly Handicapped	Total Handicapped
Noninstitutional			
Chronic Conditions:			
Visually Impaired	1,460,000	510,000	1,970,000
Deaf	140,000	190,000	330,000
Uses Wheelchair	230,000	200,000	430,000
Uses Walker	350,000	60,000	410,000
Uses Other Special Aids	2,290,000	3,180,000	5,470,000
Other Mobility Limitations	1,540,000	1,770,000	3,310,000
Acute Conditions	90,000	400,000	490,000
Institutionalized	930,000	30,000	960,000
Totals	7,030,000	6,340,000	13,370,000

NOTE: 1. Individuals who can't use transit or who use transit with difficulty.

(Source: TSC, Reference 148)

BREAKDOWN OF HANDICAPPED, ELDERLY, AND HANDICAPPED ELDERLY POPULATION, U.S., 1970

Handicapped Elderly	7,030,000
Handicapped Nonelderly	6,340,000
Elderly Nonhandicapped	13,036,000
Total	26,406,000

(Source: TSC, Reference 148)

ILLUSTRATIVE LIST OF DATA SOURCES
AGENCY AND INSTITUTIONAL SOURCES OF INFORMATION

Agency or Institution Type	Potential Type of Data: Residential Address	Economic Data	Social Data	Health Data	Trip Frequency	Ongoing Transport Services
Social Service Agencies	X	X	X	X	X	X
Health Centers	X		X		X	X
Neighborhood Centers	X		X		X	X
Senior Citizen Housing	X		X		X	X
Senior Citizen Centers	X		X		X	X
Hospitals & Clinics	X	X	X	X	X	X
Vocational Centers	X	X	X	X	X	X
Rehabilitation Centers	X	X	X	X	X	X
Employment Centers	X	X			X	X
Reduced-Fare Card -- Transit Authority	X	X				X
Private Organization (Red Cross, Easter Seals, etc.	X		X		X	X

(Source: Revis, Reference 56)

4.2.5

During the planning stage, these agencies can supply useful general information regarding the number of target market members using agency services, the travel habits of these members, and the type of ongoing transportation services (if any) offered by the agencies themselves. During the design stage, more detailed information will be assembled, including data describing the clients'

- ° Physical characteristics;
- ° General socioeconomic characteristics;
- ° Addresses (to clarify origin-destination patterns); and
- ° Historical trip patterns.

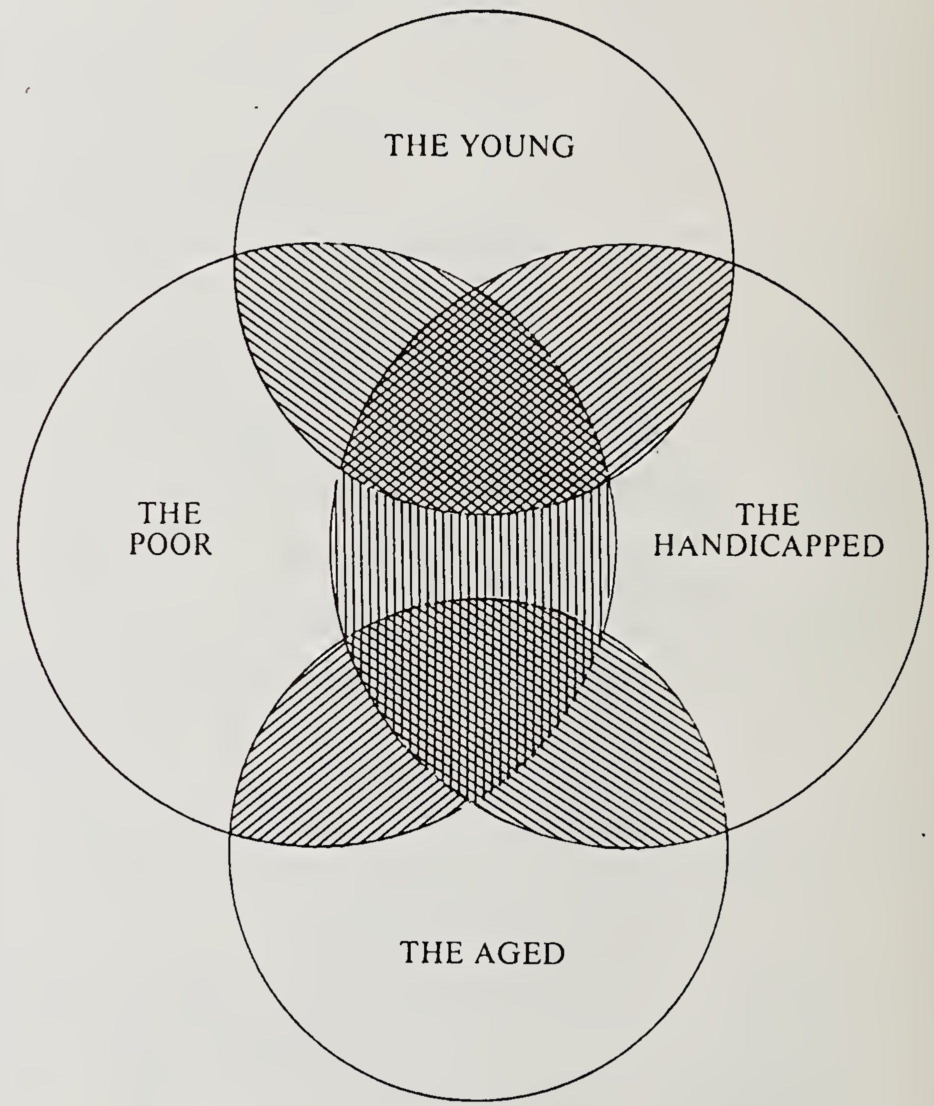
Agencies will also be of assistance if an advance survey of the target market population is needed.

(C) Advance Surveys

Advance surveys are the most reliable way to determine the relative size of the target market population and to identify the travel needs of that population. The Planning Handbook for transportation services for the elderly prepared by the Institute of Public Administration (Reference 56) provides detailed guidance on the design and administration of advance surveys of the elderly. This subsection summarizes a few of the major points raised in that document.

<u>(i) General Observations</u>. Since the travel patterns and needs of the target population can be quite different from those of the general population, advance surveys are often needed to document these patterns for system design purposes. As with general market systems, however, answers to "Will you ride..." questions tend to be wildly over-optimistic, and are

OVERLAP OF TRANSPORTATION DISADVANTAGED POPULATIONS



(Source: Falcocchio, Reference 135)

more useful for generating political support than for providing future ridership estimates. Survey responses can, however, given an accurate picture of travel patterns for design purposes.

Surveys designed to determine the travel needs of such target groups as the elderly and handicapped can be distributed efficiently through senior citizens' centers and social service agencies. A self-administered questionnaire distributed through such agencies offers a low-cost, efficient means of obtaining the desired information. The distribution of questionnaires should be closely supervised, ideally by members of the target market group themselves. The functions of such a supervisor could include:

(1) Distributing questionnaires and pencils to respondents;

(2) Briefly explaining why the survey is being conducted and relating general instructions if necessary;

(3) Encouraging respondents to ask questions when they do not understand the survey or its instructions; and

(4) Collecting the completed questionnaires.

The places where questionnaires are distributed should be numerous, diverse and representative of the major activity centers of the target group. These locales should be identified with the help of both social service agencies and members of the target market group. In the case of the elderly and handicapped, they might include senior citizen housing, churches, community service organizations, medical centers and clinics, shopping centers, and senior citizens' centers.

In the case of services designed for the elderly, a rough rule of thumb is that, for areas with less than 50,000 residents (approximately 5,000 elderly), a satisfactory sample size will be about 20% of the target group (see Reference 56).

Most of the advance survey information provided in the Creating the System (Part 2) portion of this handbook applies as well to target markets. In addition, sample target market survey forms can be found in Appendix A-10.

In addition to questions on frequency, purpose, origin, destination, time of travel, and unmet travel needs, it may also be necessary to ask members of target market groups about any infirmities that inhibit their traveling or to request proof (i.e., a doctor's certificate or a birth certificate) that a respondent qualifies for a restricted service.

<u>(ii) Advance Registration</u>. The operation of a target market system may require that rider eligibility be determined prior to use, necessitating some form of advance registration and user clearance. This registration process offers an ideal mechanism for surveying the travel habits and perceived needs of future riders. Ideally, registration centers should be staffed by members of the target population. Social service agencies and senior citizens' centers can often supply volunteer labor for this purpose.

Go to

APPENDIX A-10
for samples of target
market survey forms

4.2.5

The registration card issued by the St. Petersburg TOTE system to its elderly and handicapped riders is shown to the right. These cards, coupled with the advance registration process, served several purposes:

- The card provided the driver with a means of identifying the correct passenger.
- The registration process served as a source for tracer actions on requests for information within the administration and operations offices of TOTE.
- The number of cards issued provided a basis for determining the percentage of penetration of the target market.
- The registration number on the card was coded to supply information on the registrant's home zone, any handicap and any wheelchair requirement. Thus, the use of the registration number when making service requests conveyed considerable information and reduced the amount of time required to complete telephone orders for service.
- The registration requirement also served to educate future riders. Each registrant was provided with a TOTE brochure, and the contents of the brochure was reviewed during the registration process with the rider (Reference 126).

TOTE REGISTRATION CARD

TRANSPORTATION OF THE ELDERLY

Not Transferable

126A

Registration Number

Mrs. Mary Public

Name

140 2nd Street No.

Address

895-5571

Telephone

SPONSORS

City of St. Petersburg, Florida
Florida Department of Transportation
UMTA, U.S. D.O.T.

TOTE 895-5571

THE BEARER WHOSE NAME APPEARS ON THIS CARD RELINQUISHES ANY CLAIM FOR PERSONAL INJURY RECEIVED WHILE BEING ASSISTED ENTERING OR LEAVING A TOTE VEHICLE.

If found, please return this card to the owner or to TOTE, 140 Second Street North, St. Petersburg, Florida.

4.2.6 Eligibility

After the target market to be served has been identified, specific criteria must be established for qualifying as a member of the target market population (e.g., at what age is a rider "elderly"?). After these qualification criteria have been determined, a fare structure must be formulated that will meet the economic needs of the service yet not place a financial burden on the target market members themselves: a target market service for the elderly is of no use if the elderly cannot afford to use it.

(A) Eligibility Standards

The eligibility definition may be dictated by the sponsor, the funding source, system economics, or the goals of the provider. From information on existing systems, persons eligible for target market services usually fall into one or more of the following groups:

- ° Elderly;
- ° Handicapped;
- ° Low income persons; and
- ° Client of a social service agency.

UMTA's regulations on transportation for elderly and handicapped persons defined this special market as "...those individuals who, by reason of illness, injury, age, congenital malfunction, or any other permanent or temporary incapacity or disability, including those who are nonambulatory wheelchair-bound and those with semi-ambulatory capabilities, are unable to utilize mass transportation facilities and services as effectively as persons who are not so affected."

In San Leandro, California, the County Area Agency on Aging contracted with the City for the operation of a senior

NAME__________ Phone______ Date of Birth______

ADDRESS__________ Zip______ Age______

SENIOR CITIZEN TAXI
APPLICATION CARD

HUMAN RESOURCES DEPARTMENT
City of San Leandro, California

Need Please check appropriate box:

☐ Disabled (please be brief but specific)

____

☐ Too far from public transportation
how far______

☐ Unable to use public transportation (describe)

____

(Signature) (Date)

taxi program. The following ridership criteria were included in the contract: 60 years of age or over, and a resident of San Leandro who, because of physical or mental limitations, is unable to use public transportation (Reference 127).

Minimum age requirements for existing systems range from 55 to 65. Federal agency definitions range from 60 years old for community services provided through HEW; 62 years old for services using a Social Security definition; and 65 years old for reduced fare under federal transit regulations (Reference 117).

Requirements for the physically handicapped center around mobility impairments or the inability to use or gain access to conventional public transportation. These disabilities include physical, mental or emotional problems such as those listed in the accompanying application form. The few systems reporting low-income criteria used the federal poverty level or low-income definition. In Palo Alto, California, individual income and household income levels were established with a different subsidy plan associated with each level.

(B) Restrictions on Travel

Constraints on use of the system can be imposed on the rider in several ways, including:

- ° Residency within service area;
- ° Number of trips that can be taken;
- ° Amount of money or number of coupons or tickets that can be expended;
- ° Trip length;
- ° Trip purpose; and
- ° Trip hours.

Some of these restrictions were directly related to funding or budget constraints, some to the availability of vehicles or limits of system capacity, and some to productivity factors.

(C) Certification

Once a policy has been established, the method of certifying eligibility for system use becomes an operational responsibility. Eligibility can be handled in any one of the following ways:

- ° Enrollment in a club for a fee (OATS, Missouri);
- ° Registration with an organization or agency (TOTE, St. Petersburg, Florida, where registration began four months in advance of system initiation);
- ° Enrollment in a program or project offered by a city or county (Sunnyvale and Palo Alto, California);
- ° Certification of handicapped by a physician (Chicago, Illinois; see Appendix A-10 for sample medical certification form);
- ° Certification by social service agency as low income, elderly or a client;
- ° Telephone screening, verification, and placement in a master file at dispatch center (Baton Rouge, Louisiana);
- ° Mail-back application form (see Section 4.2.9, "Moby" in Omaha, Nebraska); and
- ° Application form distribution to social service agencies and public information agencies; mail-back certification (Dade County, Florida).

Go to Appendix A-10 for sample certification form for handicapped

4.2.9 mail-back application form

APPLICATION FORM

Baton Rouge, Louisiana

CLIENT'S NAME ______________________ AGE ____

ADDRESS ______________________

____

PHONE ______________________

DISABILITY

- ☐ VISUALLY IMPAIRED
- ☐ DEAF
- ☐ MENTAL RETARDATION
- ☐ CEREBRAL PALSY
- ☐ STROKE
- ☐ OTHER CARDIOVASCULAR
- ☐ USES WHEELCHAIR
- ☐ USES WALKER
- ☐ USES SPECIAL AIDS

OTHER ______________________

WHAT MEDICAL FACILITIES DO YOU ATTEND?
(Clinics, Hospitals, Doctors Offices, Free Medicine, etc.)

____

____

WHICH OF THESE FACILITIES DO YOU ATTEND ON A REGULAR BASIS?
HOW REGULAR? (every day, once a week, once a month, etc.)

____

____

DO YOU HAVE TO HAVE A COMPANION IN ORDER TO ATTEND THESE FACILITIES?

____

____

TO WHAT OTHER DESTINATIONS BESIDES MEDICAL FACILITIES DO YOU DESIRE TRANSPORTATION? FOR WHAT REASON? (employment, education, shopping, food stamps, welfare, social security, etc.)

____

____

WHAT AGENCY REFERRED YOU?

____

ELIGIBILITY APPLICATION AND CERTIFICATE

Sunnyvale, California

CITY OF SUNNYVALE № 2236
CERTIFICATE OF ELIGIBILITY

☐ ELDERLY ☐ HANDICAPPED

SUPPLEMENTAL TRANSIT SERVICE

____
NAME

____
SIGNATURE OF USER

____
SIGNATURE OF CERTIFIER
(SEE REVERSE SIDE FOR CONDITIONS)

CERTIFICATE NUMBER __________ DATE ISSUED __________

NAME ______________________

ADDRESS ______________________ TELEPHONE __________

Eligibility is Claimed as Follows:

☐ SENIOR - 62 Years of Age or older

- ☐ Birth Certificate (__________) Date of Birth
- ☐ Medicare Card
- ☐ Valid California Driver's License
- ☐ Other

☐ HANDICAPPED - Signed Certificate of Disability

- ☐ Social Security Administration
- ☐ Veterans Administration
- ☐ Other

I certify that I am a Sunnyvale resident and that all the above information is true.

______________________ Signature of Applicant

______________________ Signature of Certifier

4.2.6

SENIOR CITIZEN TAXI PROGRAM

San Leandro, California

Administration: Human Resources Department of the City

Objective: Aid needy senior citizens physically unable to use public transportation or lacking access to existing systems.

Entry: Application card (apply in person or telephone City Hall or Recreation Department)

If physically disabled, City will contact person for more information.

Final determination made by staff. No doctor's report necessary.

Eligibility: 60 years of age or older

Reside within City limits

Physically unable to use public transit or lacking access to public transit (income restriction was dropped)

Temporary use permitted if person has no alternative transport, or for periods of convalescence

Constraints: Trips must be within City

Trips must be for medical, shopping, personal business, or to a senior citizens' center

Limited number of coupons

HANDICAPPED SYSTEM

Dade County, Florida

Administration: County Office of Transportation Administration

Objective: Provide transportation for those who lack access to serve and those unable to use existing transit equipment

Entry: Application form with certification by doctor or person recognized by County as able to diagnose or verify handicap

Eligibility: Transportation handicap measured by existence and extent of functional mobility impairments:

- Permanent injury
- Illness
- Physical malfunction
- Other incapacity or disability

Constraints: Trips must be within County

Limited number of trip vouchers can be purchased

(Source: Developed from city and county information by SYSTAN)

4.2.7 Estimating Supply and Demand in Target Market Systems

(A) Rough Estimates of Demand

As in the case of general market systems, no single approach to target market demand estimation has shown itself to be markedly superior to other approaches. Planners are best advised to try a variety of simple estimating techniques, and rely on the flexibility of the paratransit system itself to respond to demand as it develops. Two simple planning approaches are described in this subsection:

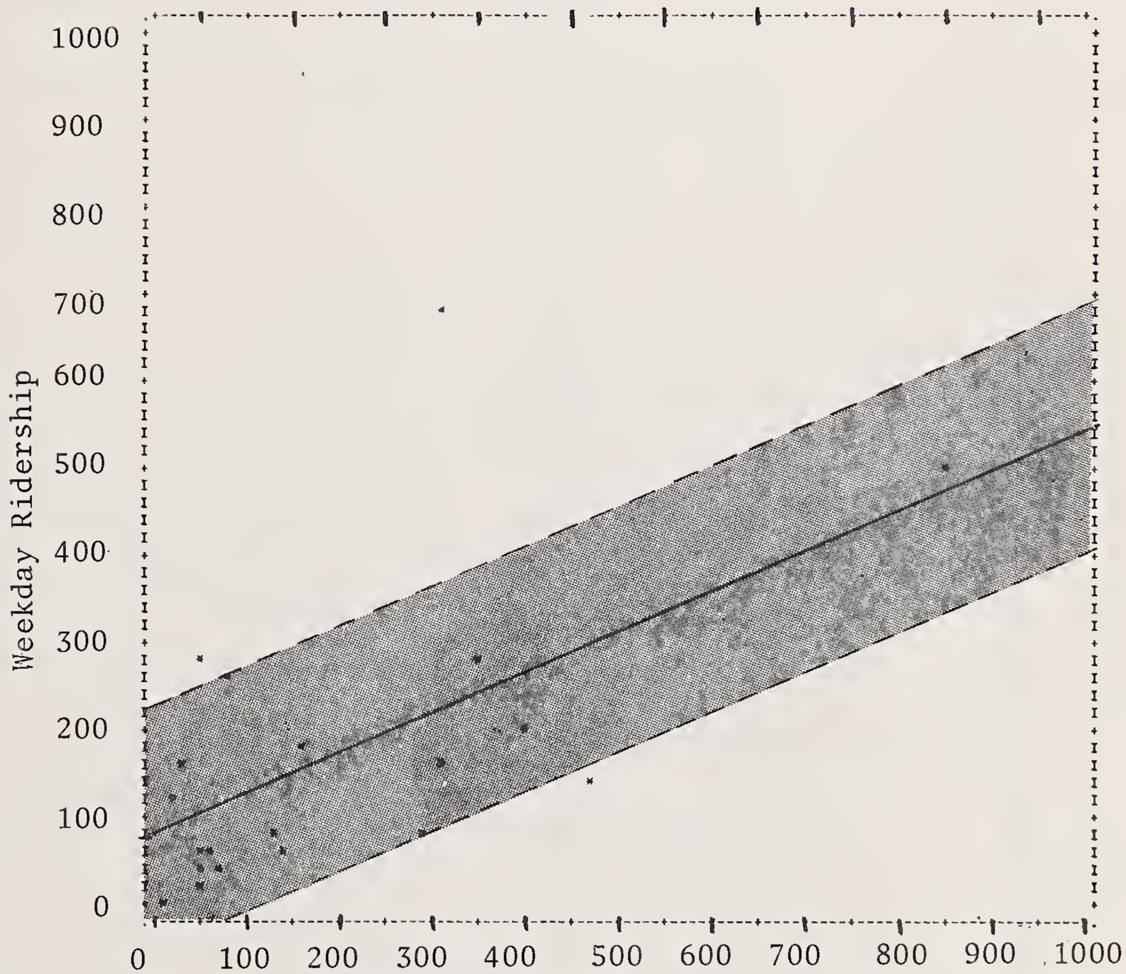
(i) Inference from other target market systems; and

(ii) Use of nomographs.

(i) Inference From Other Target Market Systems. Existing target market operations provide a means of estimating the range of likely ridership levels within a specific population area. The accompanying exhibit plots weekday ridership as a function of total service area population for a sampling of 20 target market paratransit operations.

The wide range of performance exhibited by existing systems provides a broad set of limits on likely demand levels when the service area population or population density is used to estimate these levels. The ridership on existing systems ranges from a low of 0.1 (Chicago) daily rides per 1,000 residents to a high of 8.6 (Dover) daily rides per 1,000 residents, with a median of 0.8. Measured in terms of the eligible population, the median number of rides per day per 1,000 eligible riders is 10.0, which is

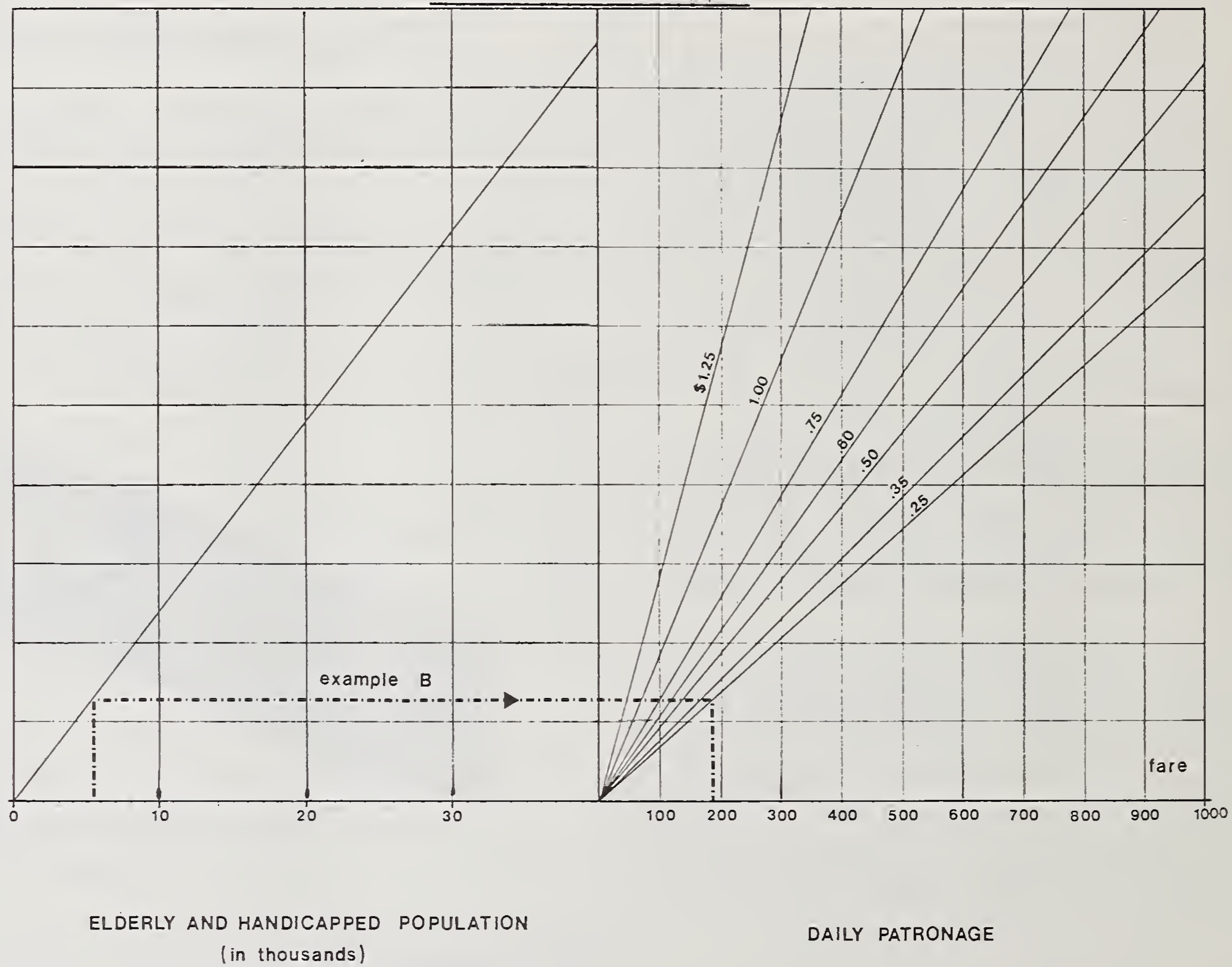
Relation of Service Area Population to Target Market Ridership



(Source: SYSTAN)

4.2.7

PATRONAGE NOMOGRAPH
ELDERLY AND HANDICAPPED



(Source: Wilbur Smith, Reference 60)

slightly higher than the median of 8.4 rides per day per 1,000 population reported for general market systems.

It is possible to narrow the wide boundaries of possible demand levels somewhat by identifying those sample points that are most similar to the system being planned. (The system descriptions in Appendix 4 can be used to identify systems similar to the system of interest.)

(ii) Use of Nomographs. The preceding exhibit contains a nomograph relating daily system patronage to the number of eligible residents within the service area and the fare level (Reference 60). To use the nomograph, determine the number of eligible residents within the service area. If the target market system is designed to serve the elderly and handicapped, the number of elderly residents within the service area may be determined from census information. Estimates of the number of handicapped may be derived from advance surveys or estimated as a proportion of the general population (see Section 3.2.2). A vertical line drawn from the number of eligible residents to the diagonal line cutting across the left half of the nomograph. A horizontal line is traced from the point of intersection with this diagonal to the selected fare level, and a vertical line is then traced to the daily patronage axis.

(B) Fleet Size Estimates

(i) Rough Planning Estimates. Because target market systems serving the elderly and handicapped tend to serve larger areas and experience longer dwell times than general market systems, the rough relationships used in estimating vehicle requirements for general market systems are generally not appropriate for target market systems.

Go to APPENDIX A-4 Individual System Surveys

D 3.2.2 Advance Surveys

EXAMPLE

Given a proposed dial-a-ride service area containing 5,600 elderly and handicapped persons, estimate the daily patronage of a system serving only the elderly and handicapped and charging a 25-cent fare. The solution, about 190 daily riders, is depicted by the dashed line in the accompanying nomograph.

(Source: Wilbur Smith, Reference 60)

4.2.7

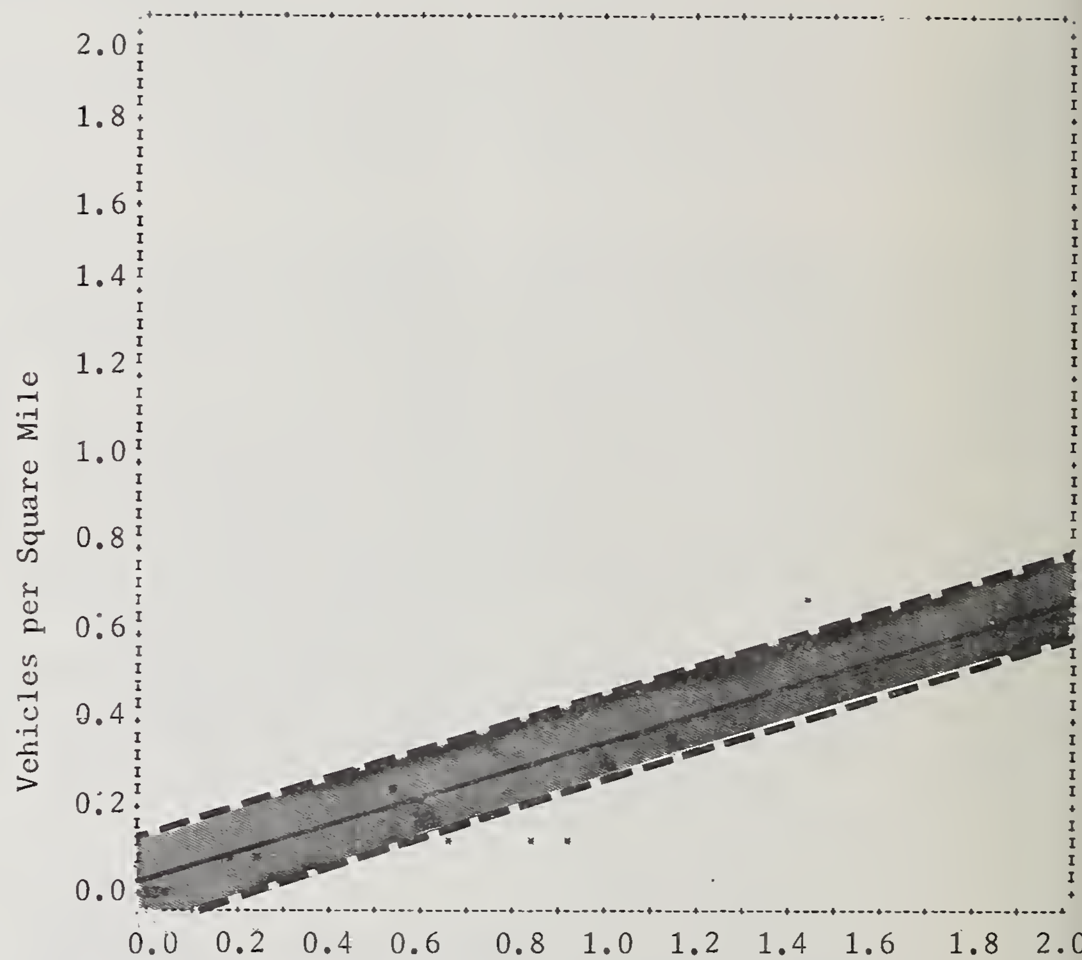
For target market systems serving relatively small areas (i.e., under 20 square miles), however, the general market nomograph in Section 2.2.10 (Creating the System) can provide a rough estimate of the required fleet size.

For target market systems serving larger areas, some guidance may be obtained from the experience of other target market systems. The accompanying exhibit plots the number of vehicles per square mile as a function of ridership density (trips per square mile per hour) for 16 target market systems. The estimating range can be narrowed by using the Individual Systems Sheets (Appendix 4) to obtain information on those systems closely resembling the planning alternatives in operating policy, fare structure, system configuration, and target market eligibility.

(ii) More Detailed Design Elements. Once the travel patterns of the target market population have been ascertained through surveys or interviews with social service agencies, fleet size estimates should be updated to reflect these patterns. The most informative way of accomplishing this is by generating a number of sample trips and driving through the service area making simulated tours designed to service these trips. Sections 4.2.5 and 4.2.9 of Creating the System discuss techniques for pretesting the system in this fashion, while Section 3.2.5 provides a straightforward formula for relating the information gained on tour time to vehicle requirements.

More detailed procedures for estimating the number of vehicles needed in a target market fleet may be found in the Planning Handbook prepared for the Administration on Aging by the Institute of Public Administration (Reference 56).

Relationship of Trip Density to Fleet



Trips per Square Mile per Hour
(Source: SYSTAN)

P 2.2.10 Fleet Size Estimation
Go to APPENDIX A-4 Individual System Surveys
I 4.2.5 Train Staff 4.2.9 Pretest System
D 3.2.5 Detailed Fleet Estimates

4.2.8 Special Equipment, Vehicles and Facilities

Aside from the basic demand-responsive transit equipment outlined in Section 3.2.8, many target market services will require additional equipment modifications. These considerations are particularly important when serving severely handicapped individuals.

To accommodate these special transit users, several communities are now retrofitting their entire fixed-route fleets; current federal policy states that all standard buses purchased with federal funds after September 1979 must include features designed to accommodate handicapped persons (i.e., Transbus), and proposed Section 504 non-discrimination regulations would require that all transit services be accessible to handicapped users. However, many cities are questioning the economic wisdom in adapting fixed-route equipment. The Bay Area Rapid Transit System (BART) in San Francisco, California, went to considerable lengths to provide for handicapped users, but discovered that additional, more personalized services were required for these riders to get to and from the BART trains. The alternative answer might be to provide a paratransit service for target populations.

(A) Identify Special Needs

Handicapped individuals have served successfully on advisory groups for target market systems to identify their special needs and related transit barriers. It should be noted that these groups will probably not be homogeneous with respect to transportation needs and mobility constraints. Denver, Colorado identified these groups of elderly and handicapped individuals to guide their transit system's vehicle design: those persons able to use:

3.2.8 Vehicle Selection

4.2.10 Staff Training

(1) Existing bus service;

(2) Buses if certain modifications are made; and

(3) Only vehicles especially designed to accommodate their severe mobility problems.

After installing special equipment in buses, many communities have then instituted special mobility training programs to instruct interested elderly and handicapped groups on how to ride fixed-route buses. Depending on the flexibility of the transit system, these sessions could be coordinated with driver re-education programs (outlined in Section 4.2.10).

(B) Equipment Options

For systems contemplating serving the severely handicapped, the following exhibit outlines basic wheelchair information for determining vehicle and lift specifications. Although other specific design details are beyond the scope of these guidelines, the items highlighted in SCRAPS Section 1.2 and 1.3 can be useful in identifying basic equipment needs. Aside from the lifts, most of these items involve relatively little capital expenditure when compared with total vehicle costs; however, lift costs typically add more than ten percent to the cost of the vehicle

(C) Selecting the Vehicle

Though economical and readily available, automobiles can present acute accessibility problems for the severely disabled. They have been extensively used by services for the moderately handicapped, especially in rural areas where the greater trip distances make the cost advantages more apparent. Personal automobiles have also frequently been used in target market services that rely on volunteer driver services.

1.2
1.3
Equipment Needs

4.2.8

BASIC WHEELCHAIR DIMENSIONS

Seat height	19½"
Arm rest height	25"
Overall chair height	36"
Individual sitting height	56-58"
Wheelchair length (with occupant)	42" 45"
Wheel-to-wheel width	25"
Functional width	32"
Wheelchair turning radius	31"
Wheel radius	12"
Folded width	11"
Wheelchair storage space	11"(W)X42"(L) X36"(H)
Standard chair weight	50 lbs.
Motorized chair weight	110 lbs.
Minimum length for two chairs, one in front of the other, both occupied	100"
Minimum width for two chairs, side-by-side, both occupied	60"

(Source: Ryden, Reference 239)

Vans converted from the standard models are the most popular vehicle for serving all target market needs. Seats can be removed and special steps, ramps or lifts added, roofs raised, etc. Depending on the extent and type of modifications, vehicle capacity will vary. For example, some vans are extremely versatile, carrying either four ambulatory and three wheelchair riders, seven ambulatory and two wheelchair riders, or eleven walk-on passengers. Small buses and motor homes can be similarly converted for high-demand target market services.

General market services accomodating special target market users will want to weigh the vehicle modification issue more carefully. While outfitting only a portion of the fleet is attractive from a cost standpoint, the number and type of users as well as the level of service must be considered. Sketchy system experience indicates that making only a few vehicles available to the handicapped users provides only limited accessibility.

4.2.9 Marketing

The distribution and type of information are the important considerations for target market populations. If the people to be served gather at one place, e.g., a senior citizen activity center or a job training center, then the distribution of schedules and instructions can be done easily at the center with written material, posters, sign-up sheets, etc.

When service encompasses an entire community, locating and reaching the target market population can be difficult. The most effective marketing tools include direct contact with target market groups or social service organizations: vehicles with eye-catching identification (logo, system name, etc.), and word-of-mouth advertising. The top exihibit at the right lists the promotional activities for the Syracuse, New York system.

Additional methods may be necessary, particularly at the time of service introduction. According to two surveys, the news media served as an important source of information for the elderly and handicapped riders of Klamath Falls, Oregon and St. Petersburg, Florida. These results are shown in the bottom exhibit at the right.

Locations where information is distributed include:

- Social service agency offices
- Senior citizen centers
- Medical facilities
- Churches
- Handicapped associations
- Retirement residences
- Nursing homes
- Job training centers

Promotional Activities
Syracuse, N.Y., Call-A-Bus

- Staff presentations to client groups of social service agencies
- Distribution of brochures to more than 80 agencies, churches, etc.
- Display posters and brochures to stores
- Wheelchair lift vehicles demonstration on local talk show
- Movie theatre reduced price ($2.50 to $1.00) for Saturday matinee arrival on Call-A-Bus
- Distribution of monthly newsletter on board the bus and sent to social service agencies (service changes, calendar of events, etc.)

KART Advertising Modes
Klamath Falls, Oregon

	%
Newspaper	48
Radio	13
Television	6
Saw bus on street	15
Friend or relative	13
Brochure or bulletin	5

TOTE Advertising Modes
St. Petersburg, Florida

TOTE materials (posters, etc.)	31
News média (papers, TV, radio)	26
Organizations	24
Individuals (friends, relatives)	19

4.2.9

The types of information found to be important for the elderly and handicapped are listed below.

"Elderly

Printed route schedules are considered the easiest information sources to use, but are generally difficult for elderly people to obtain.

The driver is viewed by the elderly as an important source of information.

Most elderly are adequately informed about service to their destination points because they maintain fixed travel patterns.

Handicapped

The bus driver and the telephone information service are important sources of information for the handicapped.

Less than one-half of the handicapped are knowledgeable about services provided by their local transit systems." (Reference 50)

Information which needs to be communicated, in addition to general marketing facts, includes:

. Who is eligible for service
. How to register, if necessary
. Medical certification, if necessary
. What special equipment is available
. Any special fare information or fare payment methods
. Any limitations on travel destinations

To illustrate how this information has been conveyed in different communites, the following exhibits have been included:

. A sample fact sheet and a passenger "tip"

PASSENGER "TIP" CARD
Cleveland, Ohio

CRT PASSENGER TIPS

We are happy that you are using the CRT service in your area. In order to provide the best possible service for the entire community, we ask that you keep these suggestions in mind.

1. WHEN CALLING IN YOUR ORDER, ASK TO SPEAK TO A SCHEDULER.
The telephone operator who first answers your call does not take ride reservations. Please ask to speak to a scheduler.

2. WHEN SPEAKING TO THE SCHEDULER, GIVE THE REQUESTED INFORMATION IN THE BRIEFEST MANNER.
In order to provide efficient service we need complete address and destination information. The longer you spend on the phone, the more people are kept waiting and the less people we can serve.

3. IF YOU ARE ASKED TO "HOLD", PLEASE BE PATIENT.
The CRT schedulers are very busy and work as quickly as possible. If there is some delay, please be patient. Your call will be taken as quickly as possible.

4. GIVE YOURSELF PLENTY OF TIME TO GET A SCHEDULED APPOINTMENT.
It is better to be a little early for an appointment to be assured of being there on time.

(continued on other side)

5. BE SURE YOU ARE READY TO LEAVE YOUR PICK-UP POINT WHEN THE BUS ARRIVES.
Have your coat and hat ready and look for the CRT vehicle. Being ready to leave on time helps the driver keep his/her schedule, and shows consideration for others using CRT in your area.

6. CALL AHEAD FOR MEDICAL TRIPS.
CRT gives medical trips top priority. Since we have a limited number of vehicles available, we hope that you will call in your reservation an extra day ahead for visits to the doctor. This will help us plan your trip to the doctor. You should be reminded that medical trips will be scheduled on a first-call, first-serve basis.

RTA
721-3500

(back of card)

FACT SHEET

Cleveland, Ohio

ATTENTION SENIOR CITIZENS AND DISABLED PERSONS

WHAT IS CRT?

CRT is the Community Responsive Transit service sponsored by your Greater Cleveland Regional Transit Authority. The service is intended to provide safe and convenient transportation for the elderly and handicapped. There are no fixed routes. Passengers may be picked up at different points during any trip.

WHO CAN USE CRT?

You can if you meet one of the following requirements:

1. You are 65 years of age or older and have an RTA Senior Citizens Pass.
2. You have an RTA Handicapped Pass.

Simply show one of the above passes to the driver as you board.

HOW CAN YOU RIDE ON CRT?

Reserve your ride one day in advance of your trip, some time between 8:30 A.M. and 4:00 P.M. For medical trips, you may reserve your ride an extra day ahead.

WHAT NUMBER DO I CALL FOR SERVICE?

The telephone number is: 721-3500.

HOW DO YOU RESERVE YOUR RIDE?

Call 721-3500 and ask to speak to a scheduler.

Give the following information:

* Your name, address and telephone number.
* Number of people making the trip.
* Time for pickup *and* return.
* Address of destination.
* If you are restricted to a wheelchair.

CAN YOU CANCEL YOUR TRIP?

Yes. If you find that you cannot take your planned trip, please let us know promptly. Do so by calling 721-3500 on weekdays between 8:30 A.M. and 4:00 P.M.

WHERE CAN YOU RIDE ON CRT?

To the doctor or the dentist.
To shop for groceries.
To club meetings.
To any place for any reason during the times of service.

WHAT DOES IT COST?

It is free to those who qualify.

SPECIAL INFORMATION

For medical appointments only -- if you find you are running late for your return trip -- have the nurse call 721-3500. Special efforts will be made to pick you up.

HAVE QUESTIONS?

Call the downtown CRT office at: 781-5100.

WHEN CAN CRT SERVICE BE USED?

You can ride CRT on Fridays any time between 9:00 A.M. and 5:00 P.M. There are no pickups made after 4:30 P.M.

4.2.9

card used in Cleveland, Ohio explaining how to use the system.

. How to register and the resulting identification card used in St. Petersburg, Florida.

. A medical certification form used in Chicago, Illinois for handicapped service (see Appendix 10).

. A brochure explaining the service offered in Omaha, Nebraska with a detachable application and travel needs survey form which was pre-addressed for delivery to the transit agency.

Additional marketing material can be found in SCRAPS Section 4.0, Marketing and Customer Information.

Go to APPENDIX A-10 Medical Certification Form

4.2 Marketing Material

St. Petersburg, Florida

SYSTEM BROCHURE WITH ATTACHED MAILBACK APPLICATION AND SURVEY INFORMATION CARD
Omaha, Nebraska

MOBY

Dear Friend:

MAT has worked long and hard to make a breakthrough in its capacity to serve handicapped persons and senior citizens who cannot ride on the regular MAT transit buses because of mobility problems.

MAT has, with the help of many local senior citizen organizations and organizations of handicapped persons, and with the help of federal and state agencies, been able to obtain vehicles and operating funds necessary to expand its specialized transit services.

The service will be called MOBY (MAT's mobilization for Special Customers) a "whale of a service" and will all come together on February 13, 1978.

If you or a member of your household may be eligible for this specialized service, please take a few minutes to read this brochure. If not, please pass it to a friend or relative who might appreciate hearing of the new service.

Services currently being provided for senior citizens will be a part of the MOBY service and will not change. Those persons certified for this service do not need to be recertified.

Love,

mat

DETACH HERE

APPLICATION

1. I, ______________________ have read
(Name of Individual)
the eligibility guidelines and believe I am qualified for certification.

2. I, therefore, request certification under (check one): ☐ Category One (Wheelchair) ☐ Category Two (Other Personal Assistance Devices) ☐ Category Three (Other-Physician's Statement Required) (MAT will provide a form for the Physician's Statement upon request)
Describe condition in full detail and state type of personal assistance device(s):

3. PLEASE PRINT OR TYPE:
Applicant's Name:
(First) (Middle) (Last)
Address:
(Street No.) (Apt. No.)
(City) (Zip Code)
Nearest Intersection:
(Street Names)
Date of Birth: __________ Phone: __________
In case of emergency, please contact: __________
__________ Phone: __________

4. Personal Data: Must you travel with an escort?
☐ Yes. ☐No
Is your mobility limitation permanent? ☐Yes. ☐No. If not permanent, estimated duration:

5. I, the undersigned applicant, do hereby state that the above information is true and complete to the best of my knowledge:

(Applicant)

(Name of person preparing form, if other than applicant)

(Address) (Phone)

(City) (Zip Code)

*USE OF INFORMATION. The intended use of the information provided by applicant, herein, is for the sole purpose of establishing eligibility for MOBY.

However, applicant should be aware that a composite statistical profile of mobility limitations will be prepared by MAT as a part of the project evaluation. No names or addresses will be used in this statistical profile.

Information provided by applicant for MOBY certification will be treated as private and not released to any other person, agency, institution, or organization without the express permission of the applicant.

TRAVEL REQUIREMENT QUESTIONNAIRE

1. Name:
(First) (Middle) (Last)
(Street Number)
(City) (Zip Code) (Phone)
(Nearest Intersection)

2. TRAVEL DATA:
A. Highest Priority Type of Trip (Check One): ☐ Work, ☐ School, ☐ Medical, ☐ Social/Recreational, ☐ Shopping, (Other)

3. **SPECIFIC NEEDS:**
I need transportation for:
WORK TRIPS (Circle appropriate days)
Days of Week: Mon Tues Wed Thurs Fri Sat Sun
Arrival time at work __________
Return trip departure time __________
Employer's Name and Address __________

SCHOOL OR TRAINING TRIPS (Circle appropriate days)
Days of Week: Mon Tues Wed Thurs Fri Sat Sun
Arrival time at school __________
Return trip departure time __________
School's name and address __________

4. OTHER TRIPS: Medical Social/Recreational Shopping
Other __________

5. Other trips normally will be taken between: (Check a time and circle a day):
- ☐ 6:00AM-9:00AM Mon. Tues. Wed. Thurs. Fri. Sat. Sun. Holiday
- ☐ 9:00AM-3:00PM Mon. Tues. Wed. Thurs. Fri. Sat. Sun. Holiday
- ☐ 3:00PM-6:00PM Mon. Tues. Wed. Thurs. Fri. Sat. Sun. Holiday
- ☐ 6:00PM-Midnight Mon. Tues. Wed. Thurs. Fri. Sat. Sun. Holiday

6. I now meet my travel needs by: ☐ Own car or vehicle, ☐ Taken by a friend or relative, ☐ Taxicab, ☐ Non-profit organization such as church, etc. ☐ Other ☐ Travel needs are not being met.

4.2.10

4.2.10 Staff Training

Simply providing physical access for most target market groups is insufficient; staff must also be prepared to handle the special needs of these users. In addition to the training program outlined in Part II, Section 4.2.5 supplemental equipment, sensitivity and medical instruction may be necessary. The exact nature and extent of these sessions, however, depends on the local service characteristics, priorities and users.

(A) Equipment

Instruct drivers in using special equipment, such as wheelchair lifts, ramps, tie-downs, step-stools, etc. A thorough explanation of how potential passengers would use the various pieces of equipment, will enable drivers to relay this information to the eventual users.

Supplemental maintenance training should cover special equipment preventive maintenance and repair procedures.

(B) Sensitivity

Most target market services have instituted some type of sensitivity training program for their drivers. Identify and incorporate those potential traveler needs that are different from general market user demands. These needs can be based on the actual physical mobility restrictions as well as the users' perceptions.

In Cleveland, Ohio each of their able-bodied drivers, as part of their training, underwent a simulated session of being both crippled and blind before driving their first run. In addition, a panel of elderly and handicapped persons told the new drivers of their particular problems in boarding and alighting the vehicle and what they needed in the way of assistance. In Austin Texas, drivers received sensitivity training from those organizations directly involved with the users, as shown in the driver training schedule exhibit. Other systems have similarly relied on their advisory group representatives for sensitivity and awareness issues.

Elderly and handicapped users may require:

- -assistance in boarding and alighting vehicle.
- -slow, smooth vehicle starts and stops.
- -door-through-door service.
- -help in carrying packages.
- -additional assistance during inclement weather.

If the service is to be coordinated with general market users, encourage greater public awareness of the problems of the transportation handicapped need through marketing awareness programs.

(C) Medical

Check state regulations for driver medical training requirements. Target market drivers should be physically able to assist users. Films and brochures may be available from local social service or health agencies explaining the various medical handicaps and disabilities. Tracy, CA's target market service showed drivers a film on epilepsy and the various types of seizures. Programs and films on firstaid training can also be obtained from the American Red Cross, or from the local police or fire departments. These educational tools may be useful in handling emergency

4.2.5
Training Program

DRIVER TRAINING PROGRAM USED IN AUSTIN, TEXAS

First Day	
8:00 am to 10:00 am	1. Orientation 2. Job requirements 3. Operating procedures and policies 4. Basic introduction
10:00 am to 10:15 am	Break
10:15 am to 12:00	1. Visual aides 2. Handling of the mobility impaired 3. a) wheelchair passengers 1. lifts 2. tie-downs b) ambulatory-passengers 1. assistance in boarding and deboarding 2. "door-to-door" service
12:00 to 1:00 pm	Lunch
1:00 pm to 4:00 pm	First aid training (taught by the City)
Second Day	
8:00 am to 12:00	Sensitivity training 1. General introduction 2. Elderly citizens training - RSVP 3. Blind citizens training - School for the Blind
12:00 to 1:00 pm	Lunch
1:00 pm to 4:00 pm	Sensitivity training (continued) 4. Wheelchair citizens training - MIGHT 5. Cerebal Palsy citizens training - MIGHT 6. Deaf-blind citizens training - School for the Blind
Third Day	
8:00 am to 12:00	Simulation (Practice with/drivers)
12:00 to 1:00 pm	Lunch
1:00 pm to 4:00 pm	First aid training (taught by the City)
Fourth Day	
8:00 am to 12:00	On the Job training with the OPW program
12:00 to 1:00 pm	Lunch
1:00 pm to 4:00 pm	First aid training (taught by the City)
Fifth Day	
1:00 pm to 3:00 pm	* Map reading and street location training and examination Conclusion of First aid training (taught by the City) Continue with regularly scheduled work day.

* New area of training

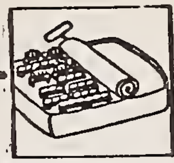
Source: Austin Transit System

medical situations.

(D) Additional Training

After the formal classroom instruction, an informal discussion session between employees and the target market users and representatives can provide ample opportunity for answering any additional questions. These groups may also be willing to participate in some initial simulated exercises to iron out any problem areas before the service is initiated.

Syracuse, N. Y.'s Call-A-Bus service saw the need to instruct passengers as well as employees, and held special sessions prior to implementation. Some target market users may require additional instruction in how to call and request service and in boarding and alighting from vehicles.



COMMENTS ENCOURAGED

This document contains an aggregation of material from paratransit systems throughout the United States and Canada. It also contains a five-stage process for creating a system which was developed from the experience of existing systems. As you use it, we are certain you will have comments and suggestions and we want to hear them. Your comments and answers to the questions below will be useful and appreciated.

How did you use the Handbook?

- ☐ to catch up on the state-of-the-art
- ☐ to plan a system
- ☐ to assess paratransit potential in your community
- ☐ to find information on a particular aspect of paratransit which aspect? ________
- ☐ to consider creating a system
- ☐ other: ____________

What part(s) did you use most often?

- ☐ 1 Introduction
- ☐ 4 SCRAPS
- ☐ 2 Creating the System
- ☐ 5 Appendices
- ☐ 3 System Characteristics

What sections need more information?

Section:__________ Topic: ______________

Any other information you would like to see added?

____

Would periodic updated data or information be useful?

☐ Yes ☐ No

Did you find the Handbook helpful? ☐ Yes ☐ No

Strengths	Problems
☐ clear	☐ inadequate information
☐ well organized	☐ organization
☐ comprehensive	☐ not applicable to our situation
☐ uniquely useful	☐ other: ____________
☐ other: ____________	

(Optional)

Name: Telephone #:

Organization:

Address:

Do you operate a paratransit system? ☐ Yes ☐ No

Considering one? ☐ Yes ☐ No

Planning one? ☐ Yes ☐ No

(Space for Federal messages required)

ATTN: Paul Bushueff DTS-721
Research and Special Programs Administration
Transportation Systems Center
Cambridge, Massachusetts 02142

USER'S GUIDE

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