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SMALL TRANSIT VEHICLE SURVEY

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16. Abstract

Small transit vehicles, defined as those vehicles seating 7-25 passengers and intended for public transportation use, are available in a variety of makes and models with markedly different characteristics affecting both operators and users. This report documents the specifications and operating experience of small transit vehicles available in the United States.

Despite the fact that the demand for small transit vehicles has only recently begun to grow there are many more manufacturers of these vehicles than there are of full size transit vehicles. This report provides a summary of the availability and operational experience of small transit vehicles in the United States.

Vehicles are divided into three main categories: vans and van conversions, small buses, and converted motor homes. Operating experience was obtained by sampling from manufacturer provided user lists. Vehicle specifications were obtained directly from the manufacturer.

No vehicle has been completely free of problems; no one vehicle is clearly superior to all others, nor is any one category of vehicle clearly superior to any other. A vehicle operator must weigh a number of variables before determining which vehicle is best for a particular application.

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PREFACE

This survey was conducted by ECI Systems, Inc. under the sponsorship of the Office of the Assistant Secretary for Systems Development and Technology, U.S. Department of Transportation. The report was prepared by Martin Flusberg and Brian Kullman of ECI Systems, Inc. and Robert Casey of the Applications Division, Transportation Systems Center. The authors gratefully acknowledge the assistance and suggestions provided by Katherine O'Leary of the Office of R&D Policy and Charles Daniels of the Urban Mass Transportation Administration, Office of Research and Development, Bus Programs Division.

The objective of this survey was to determine the availability of small transit vehicles and to sample the operating experience of those in use. This document is intended to summarize the data obtained as well as to provide some insights into issues which the potential user should examine.

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1. INTRODUCTION

Although small transit vehicles have been available in one form or another for many years, only in recent years has the demand for this type of vehicle begun to grow. Innovation in transportation, particularly in the form of such para-transit[1] services as demand response transportation (DRT), has created a steady growing market for vehicles in the 7-25 passenger range. With renewed interest in mass transit as a result of environmental concerns and more recently the energy crisis, both the demand for and the supply of small transit vehicles has increased significantly.

Small transit vehicles are being used to provide transportation in low density suburban areas, usually characterized by narrow, winding subdivision streets through which large buses could not easily maneuver. (High density areas are also candidates for shared ride circulation service.) Small transit vehicles are used to transport the elderly and handicapped, to provide general point-to-point transportation, or to bring people to line-haul transit services. They are operated by regular metropolitan transit systems and by private groups as well.

Despite the fact that limited demand for these types of vehicles existed until recently there are far more manufacturers of small vehicles than there are of full size buses. While many of these small vehicles are similar, some have distinguishing characteristics. No single vehicle is appropriate for all possible applications; a large scale demand responsive transportation system might require a totally different fleet than a smaller scale operation providing transportation for the handicapped. An operator faced with a decision as to which vehicle to buy must analyze a large number of variables before determining those most suitable for his particular application.

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[1] Para-transit connotes a family of transportation services characterized by passenger ride sharing. These services are likely to employ small-sized vehicles such as minibuses, vans, limousines, station wagons, or regular automobiles as in the case of taxis.

Scope of the Report

This report provides a reference on 7 to 25 passenger bus type vehicles available in the United States as of April 1974. While an attempt was made to survey all such vehicles, a rapidly expanding, dispersed supplier industry made it difficult to ensure complete comprehensive coverage in this report. Thus, some less frequently used or recently introduced vehicles may not have been included, though every effort was made to avoid this possibility. General descriptions and specifications are provided for each vehicle in the body of the report and in the Appendices. Where applicable, a sample of findings resulting from operating experiences with the vehicles is presented, but the reader should interpret these with care. They are not intended to be used as a basis for purchase decisions, but rather to illuminate some of the issues to be further investigated before vehicle selection is made.

This report focuses primarily on vehicles with seating capacities greater than that of conventional automobiles, although it is recognized that conventional automobiles can be utilized to deliver demand responsive service. A number of taxi companies are currently offering shared-cab service with their fleets. Regular station wagons which might seat more than 7 passengers are excluded. So are limousines such as those used for airport transportation. Small school buses are also not discussed although some (such as the Wayne Busette being used in Ottawa, Canada) have been modified and used in transit service.

Since vehicle requirements for transit operation vary markedly from requirements for such applications as hotel courtesy cars, in the cases where vehicles have been used in both applications only the transit applications will be stressed.

Section 2 discusses by class the various general types of small vehicles that exist, and more specifically focuses on some of their technical characteristics.

Section 3 provides a complete discussion of each vehicle. Included are general descriptions, a discussion of options, prices and availability, and a report on some operational experiences.

Section 4 summarizes the basic findings of this report.

A vehicle user list is provided in Appendix A. Appendix B provides a comparison of the technical specifications of each vehicle.

Vehicle specifications and prices were obtained directly from the manufacturers. Whenever possible complete user lists were obtained. Findings reported by operators were obtained by sampling from the user list and contacting the operator directly. If any vehicle experience has been documented, the source document was used and is cited.

2. TYPES OF SMALL TRANSIT VEHICLES

The term small transit vehicle is intended to classify vehicles according to seating capacity rather than vehicle type. Many specific characteristics vary from vehicle to vehicle. There are, however, some logical groupings within the small vehicle designation, and for the purpose of this report the 7-25 passenger vehicles have been classified in the following manner.

2.1 VANS AND VAN CONVERSIONS

A number of regular production passenger vans have been used for various transit applications. These vehicles can generally seat from 7 to 16 passengers. They are approximately the same size as a standard passenger car, and in fact some are as small as a compact car (in terms of length).

These vans are mounted on a light truck chassis, usually with a number of optional chassis available. Truck tires (which are stronger than regular automobile tires) are sometimes available. All of the vans use regular automobile engines. These vehicles typically cost about $5,000.

Because of their small size, van type vehicles are generally highly maneuverable. They have been most commonly used for such applications as hotel courtesy cars or for transporting school children. Some of them have been used to provide para-transit services.

When they are used for transit purposes the vehicles are usually ordered with the strongest chassis, heavy duty brakes, and truck tires. Nevertheless, these vehicles have been designed basically as automobiles and many of the components are not designed for heavy stop and go transit use. Their crowded seating and lack of adequate headroom also have made them unattractive for some transit applications; the elderly in particular have complained about the cramped interiors and the difficulty of boarding and alighting from some vans. Their single rear wheels

(all full-size buses have dual rear wheels) may not provide the stability and traction desired by some transit operators.

Some companies are now modifying vans to make them more desirable for transit use. Among the changes made are:

(1) A raised roof to accommodate standees and to allow easier entry.

(2) Reinforced walls and roof.

(3) Deluxe interior.

(4) Driver operated door.

(5) A strengthened suspension and heavy duty brakes.

These basic modifications cost about $5,000. Further modifications may also be made. For example, wheelchair lifts are offered by a number of manufacturers and cost from $2,000 to $4,000.

2.2 SMALL BUSES

Vehicles in this category have generally been designed for use as a bus. They usually have greater seating capacity than passenger vans, and visually resemble conventional buses more closely.

There is a wide variation in the design and construction of the vehicles in this classification. Full size transit vehicles utilize unitized construction; that is, the body and chassis are designed as one piece. This type of construction is designed to provide a long life under stop and go transit operation as well as a fairly smooth ride. A number of small buses are constructed in a similar manner. The majority of small buses, however, are constructed by placing a body on a (separately constructed) truck chassis. This type of construction is similar to the type used for the previously discussed passenger vans.

Gasoline engines are standard on all vehicles in this class with the exception of one diesel-powered foreign made vehicle and two newly developed electric vehicles. Diesel engines are available as options on some models. Some manufacturers will convert

gasoline engines for propane or natural gas operation.

Diesel engines tend to be less polluting and more economical than gasoline engines. They are often preferred by transit operators who have had experience with full size diesel powered transit vehicles. Their major disadvantages are added weight, high noise level, and exhaust odor.

Propane and natural gas systems are being tried primarily because of their low pollution levels. Because of the difficulty in obtaining these fuels, because of the novelty of this approach, and because of problems experienced by some operators who have experimented with them, they have not as yet been introduced on a broad basis in public transit.

The heavy transit bodies that vehicles in this class generally have, plus the stop and go nature of transit operation can have a serious effect on various other vehicle components. The brakes are one of the major components that are adversely affected by the above two factors. An indicator of potential brake problems is the vehicle weight/brake lining ratio. Because of their heavy weight some of the vehicles have been underpowered. Power to weight ratio is therefore another important indicator. Standard automotive engines might not stand up to this type of service and thus most, but not all, of these vehicles are equipped with heavier duty truck engines.

Most of the vehicles in this class utilize a standard automotive or truck type spring suspension. A fairly heavy duty suspension is necessary for transit operation. Recently some manufacturers have begun using an air suspension system (in which springs are replaced by air-filled bellows) similar to the suspension used in full size buses. This type of suspension should result in a smoother ride.

2.3 CONVERTED MOTOR HOMES

A number of small buses that are available have been built on motor home chassis (which are essentially light truck chassis). Some have, in fact, utilized modified motor home bodies.

With the energy crisis adversely affecting the sale of motor homes, many motor home manufacturers are attempting to expand their market by modifying their vehicles and selling them as small buses. At least five such vehicles entered the market in the first few months of 1974.

The changes made in the motor homes in order to create small buses vary from vehicle to vehicle. In most cases the major change so far has been the addition of seats and windows to the passenger compartment.

Since motor homes are designed essentially as automobiles, the applicability of motor homes for transit operation is not clear. It remains to be seen how vehicle components will stand up to transit operation.

None of these vehicles have yet been placed into transit service in the United States, although one make of vehicle has been in operation in Canada since September 1973. It is conceivable that shifting demand and an oversupply of these vehicles may force some of the motor home manufacturers out of the market. The vehicles that do become operative will undoubtedly undergo a number of changes and improvements during the process.

3. OPERATIONAL EXPERIENCES OF SMALL TRANSIT VEHICLES

Each of the small transit vehicles available in the United States is discussed in this chapter. The general description of the vehicle includes information on options, prices, and availability. Some indication is given of the number of vehicles currently in use in the United States and Canada. A sample of operating experiences is then discussed briefly with emphasis on

- Number of vehicles
- Type of use
- Vehicle age
- Daily usage
- General findings reported by operators.

The vehicles are divided according to the categories presented in the previous chapter. Two other categories, discontinued vehicles and planned models, are discussed briefly.

A user list is provided in Appendix A. A comparison of technical specifications appears in Appendix B.

There are many factors which the reader should keep in mind while reading this section. The first is that this was a very short study in which only a small sample of operations was investigated. There is always the danger that such a small sample will not give an accurate measure of a vehicle's performance. In addition, the amount of preventive maintenance performed, the type of handling by drivers, and weather conditions can vary significantly from system-to-system. They have a significant influence on vehicle performance and durability, but detailed reporting of maintenance practices was considered beyond the scope of this study and the reader is cautioned to keep this in mind.

Furthermore, the nature of the investigation was such that the troublesome aspects of each vehicle tended to surface to a greater

degree than the satisfactory aspects although the effort was made to achieve a balance between the two. Since some of the field experience data was already on hand and in some instances the operator could not provide equivalent information, the same performance characteristics are not always treated in each case. Finally, the data for this study was collected during the early part of 1974. Since that time new small transit vehicles have appeared on the market and modifications and improvements have been made to others included in this study. Consequently, anyone contemplating the purchase of a small transit vehicle should conduct a further investigation, although this report should provide some insight into issues to examine, as well as data on vehicles that are available to the potential user.

3.1 VANS AND VAN CONVERSIONS

As noted earlier the vans that have been used as small transit vehicles are standard production model passenger vans. As such they are distributed by individual automobile deaters, and no single user list is available. For the most part the standard vans are not used for transit purposes, but are more likely to be used by private organizations for their own purposes. Some of the vehicles have been used to provide public transportation, and in fact vans were widely used in early demand responsive transportation experiments.

Some companies have marketed a version of their van converted by another company to make it more appropriate for transit operation as noted in Section 2. A number of companies specialize in converting vans and then marketing the van conversions themselves. Other companies perform van conversions for specific operators but in general do not market the vehicles. Vehicles converted in this latter manner generally do not have a special name and thus have not been included in this report.

From the data reported, brake life appears to be the most constant and frequent problem. Some vehicles require replacement or brake linings every 3,000 to 4,000 miles. Some, however, have lasted 15,000 miles. Transmissions and engines were generally

reported to last 100,000 miles or more. The shortest lifetime of transmissions was less than 65,000 miles. Fuel mileage ranged from 5 to 8 miles per gallon for these vehicle types.

DODGE VAN, MAXIVAN

Dodge designs a number of passenger vans under the name Sportsman. Two wheelbases and three different chasses are available.

Figure 1. Dodge Maxivan - Exterior View

Figure 2. Dodge Maxivan - Interior View

GENERAL DESCRIPTION

The regular van is available in two lengths, one only 176" long, or the size of a subcompact American car, and the second 196" long, or about the length of an intermediate car. The Maxivan is a stretched version measuring 212". Seating capacity ranges from 5 up to 15. There are a number of possible door combinations, including a wide sliding door.

A 6 cylinder 225 cu. in. engine is standard on all models except those with the strongest chassis which have a 318 cu. in. V8. Automatic transmission is standard on all models with the strongest chassis. Heavy duty suspensions, axles, and cooling and electrical systems are available.

These vehicles range in price from about $4,000-$6,000. A number of them have been used in transit applications, but the majority are probably used for various smaller scale operations.

OPERATING EXPERIENCE (see also Fortivan)[1]

1. Buffalo, New York - The Gold Star Taxi Company provides a government funded, free door-to-door transportation system for the blind, elderly and handicapped living in the Model Cities area of the city. The company is using seven 1971 eleven passenger Dodge vans and recently purchased three 15 passenger Maxivans. The older vehicles have about 100,000 miles on them.

Findings - No major problems have been experienced with these vehicles thus far. The vehicle chassis have held up fairly well.

2. Regina, Saskatchewan - Regina is now using six Dodge Maxivans, obtained over the last 2-1/2 years, to provide their Telebus service. The vehicles have been converted by Funcraft Industries of Cambridge, Ontario. They have a raised fiberglass roof and some interior appointments.

[1] Fortivan is the name given to a family of van conversions performed by Coach and Equipment Sales Corp. and reviewed later in this section.

The vehicles are equipped with a Chrysler 318 cu. in. V8 engine. The vehicles have between 35,000 and 65,000 miles on them and have averaged about 32,000 miles per year while operating up to 150 miles per day. The forward facing seats on the earlier models were replaced because of the crowded seating; all the vehicles now have perimeter seating with room for 14.

Findings - There were severe transmission problems during the winter months of 1973 and 1974. Eight transmissions had to be replaced. The operator suspects that the positraction rear axle might have had something to do with this problem. There have also been problems in getting the front disc brake pads; brakes have been lasting 6-7,000 miles.

The vehicles have been averaging about 8 miles per gallon.

FORD ECONOLINE, COURIER

The Ford Club Wagon, usually known as the Econoline, is the basic Ford passenger van which seats 5-12 passengers. Various modifications and adaptations are made by other manufacturers to make the vehicle suitable for other purposes. For example, a school bus option includes a more powerful electrical system and special interior touches.

Figure 3. Ford Econoline - Exterior View

Figure 4. Ford Econoline - Interior View

GENERAL DESCRIPTION

Two different sized vehicles are available, one built on a 105" wheelbase, and one on a 123.5" wheelbase. Truck tires are standard on the larger model. A 250 cu. in. 6 cylinder engine and manual transmission are standard, but a 302 cu. in. V8 and automatic transmission are options.

Because the vehicle is not sold by a single distributor it is very hard to say how many vehicles are in some sort of transit use around the country. Econolines are used as school buses, by many hotels for shuttle service, and in similar applications. Some of the early DRT[1] systems used Econolines.

The base vehicle costs between $4,000 and $5,000. Delivery delay is about two months.

Ford was very active in early DRT research. Part of that research led to the development of the Courier, a modified version of the Econoline.[2] Courier modifications included:

(1) A raised roof to accomodate standees

(2) A driver operated passenger door

(3) A lower step for ease in entry

(4) A deluxe interior

(5) A modified seating arrangement

(6) Larger brakes, heavier duty suspension, and the V8 engine.

Ford tested the Courier in the Mansfield, Ohio Dial-a-Ride System. After one year of operation in which the vehicle had driven 20,000 miles Ford decided that the vehicle was suitable for DRT applications and decided to market it. Up to that point the vehicle had needed only minor maintenance, and had performed as well as the standard Econolines used in the system.

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[1] Demand Responsive Transportation (also commonly referred to as dial-a-ride, dial-a-bus, etc.).

[2] Ford Motor Co., Transportation and Planning Office - Mansfield Ohio Dial-a-Ride Experiment, 1970.

The Courier conversion was performed by Motor Homes, Inc. of Lorraine, Ohio. Depending on the options selected the vehicle cost was $7,500 to $9,000. The Courier conversion is no longer being made.

OPERATING EXPERIENCE (see also Fortivan)

1. Ann Arbor, Michigan - Ann Arbor placed two 1968 model Econolines into a DRT service in September of 1971. At that time they also leased a Ford Courier from Ford. In the 2-1/2 years since the start of the project all three vehicles have totaled over 100,000 miles each. The Econolines now have about 125,000 miles on them.

Findings - There has only recently been transmission and engine work done on the Econolines.

2. Bay Ridges, Ontario - Bay Ridges obtained five Ford Couriers in 1971 to provide Dial-a-Bus feeder service (to the GO Transit station).[1]

Findings - The master brake cylinders had to be replaced at 18,000 miles, and brakes were relined at about 15,000 mile intervals.

- The air compression passenger door system did not operate properly and had to be replaced by an electrically operated door.
- The roof exhaust fans were found to be totally inadequate for the system.
- The low speed operation was extremely rough on the automotive spark plugs.
- Truck-type tires were needed in place of automotive tires.

3. Chemung County, New York - Chemung County Transit has been operating five Ford Couriers for about three years. The vehicles provide fixed route bus service for two towns in Chemung county. The vehicles all have in excess of 100,000 miles on them.

[1]Ontario Dept. of Transportation and Communications "Dial-a-Bus: The Bay Ridges Experiment," 1971

Findings - Transmissions and engines were replaced on all of the vehicles at about 100,000 miles. One body has had to be refurbished.

COACH AND EQUIPMENT SALES CORPORATION: FORTIVAN

The Coach and Equipment Sales Corporation of Penn Yann, New York modifies standard vans for use in transit or school bus operations. The transit version is known as the Fortivan Commuter.

Coach and Equipment performs conversions on Chevrolet (GG313-05), GMC (TF31305), Dodge (B300), Dodge Maxivan (B300X), or Ford Econoline (B345) chassis. The engines and transmissions are functions of the chassis used. Vehicle length and wheelbase also depend on the chassis chosen.

Figure 5. Fortivan Commuter - Exterior View

Figure 6. Fortivan Commuter - Interior View

GENERAL DESCRIPTION

The transit conversion includes a raised steel roof that increases interior height to 75". The entrance door is extended into the roof and is also 75 inches high. The other major feature of the conversion is the customized interior. Coach and Equipment also strengthens the wall and roof supports. Seating arrangements allow up to 16 seated passengers. A hydraulic wheelchair lift is available. Space for one wheelchair and 10 other passengers is standard on the lift-equipped vehicle.

About 24 Fortivan commuters are in transit use throughout the country (and Canada); an additional 15-20 vehicles are used for other applications. The vehicles sell for about $10,000, air conditioning included. The wheelchair lift conversion costs an additional $2,000. Current delivery delay is on the order of 16 weeks.

OPERATING EXPERIENCE

1. Ann Arbor, Michigan - Ann Arbor received three Fortivan Dodge conversions during the summer of 1973. One vehicle is equipped with a wheelchair lift. The vehicles have travelled an average of 22,000 miles.

Findings - Each vehicle is currently on its third or fourth set of brake pads. The brakes have been lasting for just over 5500 miles.

There have been serious problems with the front springs. The operator associates this with the fact that for some reason the vehicle is equipped with the front end of the Dodge 200 series chassis, despite the fact the the vehicle is mounted on a heavier Dodge 300 series chassis.

2. Bramalea, Ontario - Bramalea, Ontario obtained three Fortivan conversions of the Ford Econoline in September of 1973. The vehicles are used for a DRT system. The vehicles seat 11 and have a 330 cu. in. Ford V8 engine. Each vehicle had recorded about 24,000 miles by March 1974.

Findings - The major problem to date has been the brakes: brake relinings are occurring at a rate of about once every three or four weeks, or every 3,000 to 4,000 miles. The only other problem has been the upholstery, which has begun ripping.

The vehicles have averaged about 5-6 mpg.

The operator has received complaints from passengers that the vehicle is cramped, despite the perimeter seating. Some drivers have reported that the turning radius of the vehicle makes negotiating cul de sacs and other narrow residential streets sometimes difficult.

CHEVROLET SPORTVAN

Chevrolet calls its version of the passenger van the Sportvan. Three models are available, each placed on a different chassis.

Figure 7. Chevrolet Sportvan - Exterior View

Figure 8. Chevrolet Sportvan - Interior View

GENERAL DESCRIPTION

The heaviest chassis (G30 series) is most suitable to transit type use. Two different wheelbases are available. A 250 cu. in. 6 cylinder or a 350 cu. in. V8 engine are standard depending on the chassis and wheelbase combination. Automatic transmission is an option. The smallest version seats five persons, while the larger versions can seat up to 12.

Base price of the largest vehicle is about $4,400. Delivery delay is about two months.

No transit use applications of this vehicle have been uncovered.

Chevrolet recently introduced a modified version of this vehicle designed to make it more suitable for transit use. The vehicle is a G30 series van converted by Recreational Vehicles, Inc. of Warren, Ohio. The conversion is similar to the conversions discussed previously, although little information is yet available. The vehicles are being distributed through regular Chevrolet dealers. The vehicle's name could not be obtained at the time of this report.

SUPERIOR COACH, CONSERV-A-RIDE I

The Superior Coach Division of the Sheller-Globe Corporation has recently entered the small bus market with two conversions labelled Conserv-a-Ride I and Conserv-a-Ride II. Superior Coach is one of the largest manufacturers of school buses.

Figure 9. Conserv-a-Ride I - Exterior View

Figure 10. Conserv-a-Ride I - Interior View

GENERAL DESCRIPTION

Conserv-a-Ride I is a conversion of a standard Chevrolet G-30 van. The van is reinforced, and widened 14". In addition, the roof is replaced with a slightly raised fiberglass roof which provides for 61" headroom inside. Different seating arrangements allow up to 13 seated passengers.

The basic vehicle costs $8,500. Expected delivery delay is ten weeks.

No vehicles have as yet been placed in service.

Conserv-a-Ride II is a modified motor home and is discussed in a later section.

3.2 SMALL BUSES

The vehicles described in this section have been designed by their manufacturer for use as a bus. In many cases the vehicles have chassis and engines common to other types of vehicles. The components, however, have been selected to meet the rather hard use that transit vehicles undergo due to frequent stopping and large gross vehicle weight.

These vehicles are typically larger than the vans and van conversions and have the general appearance of a bus.

These vehicles are offered with a variety of power plants, including gasoline, diesel, propane, liquid natural gas, and electric. Electric vehicles are discussed under a separate subsection.

3.2.1 Conventionally Powered Vehicles

The small buses described here are all powered by fossil fuels burned in internal combustion engines. Some have diesel fuel systems. Power plant differences are the result of varying operator needs for power, economy, ease of maintenance, noise, and pollution control.

As with vans, the most frequent major replacement item is the brake linings. Linings have reportedly lasted from a low of 3,000 to a high of 35,000 miles with 12,000 to 15,000 miles being about average. Transmission life has ranged from 24,000 to 100,000 miles with the majority under 50,000 miles. Fuel mileage has varied from 4 to 15 miles per gallon with 5 to 6 miles per gallon being most typical.

CARPENTER CADET

Carpenter is a body manufacturer that has been in the small bus market for a number of years. Their major product is school buses, but they do design small transit vehicles with a number of different body configurations.

Figure 11. Carpenter Cadet - Exterior View

GENERAL DESCRIPTION

The Carpenter Cadet can be ordered as either a school bus or transit vehicle. Carpenter designs only the body and mounts it on a Chevrolet Step Van chassis. (The Step Van is a commercial cargo type van.) Ford, General Motors, and International Harvester chassis may also be used.

The vehicle seats 12-26 passengers. Base price is about $8,000; air conditioning is optional; a ramp for wheelchairs is

available and costs $660. Delivery delay is estimated at four months.

The manufacturer only sells units to distributors, and thus has no information on where units are being used. The Northeast distributor, Cottrell Bus Sales, says only three have been sold in the area.

OPERATING EXPERIENCE

1. Torrington, Connecticut - Three units are being used on fixed route transit service in Torrington, Connecticut.

Findings - The vehicles were received in February 1974, and thus very little operating information is available.

FLXIBLE FLXETTE

Flxible is one of the three major manufacturers of full size transit vehicles in the United States (the others being General Motors and AM General). Flxible began manufacturing the 19-23 passenger Flxette in 1967

Figure 12. Flxible Flxette - Exterior View

GENERAL DESCRIPTION

The Flxette is built on a Ford truck chassis and is powered by a Ford 390 cu. in. V8 engine. A 6 cylinder Ford engine was originally standard. A few other changes have been made as a result of experience with the vehicle, but the basic vehicle is the same today as in 1967.

Base price of the vehicle is $15,000. Air conditioning is available for an additional $1,500. A hydraulic wheelchair lift is available and is installed in the rear door. (Vehicles can be

equipped either with or without the rear door.)

The Flxette is probably the most widely used vehicle of its type in the country today. They are used in transit applications in 56 cities; as shuttles in 16 airports; for sightseeing and charter operations by 19 companies; and for internal purposes by about 20 industries and universities.

Current delivery delay is estimated by the company to be about three months.

OPERATING EXPERIENCE

1. Batavia, New York - In October 1971 "Dial-a-Bus" service replaced an existing single bus route in this city of 17,000 located midway between Buffalo and Rochester, New York. This service is provided by three 1971 model and one 1972 model Flxettes. The vehicles seat 23 and have a large storage area. The vehicles are currently averaging 120-140 miles per day and have from 29,000 to 85,000 miles on them.

Findings - The brakes have been the most serious problem to date. Brakes have been relined at least every 12,000 miles, and in some cases as frequently as every 3,000 miles.

- There have been some engine valve problems, and valves have been replaced on all vehicles with 50,000 miles or more.
- There have been transmission problems, and the transmissions have been replaced on the vehicles having both the highest and lowest mileage.
- Fuel mileage has averaged 5-6 mpg.

2. Columbus, Ohio - Four 19 passenger Flxettes began operating in the Model Cities area of Columbus in November 1971.[1] They provide a route deviation DRT service. The vehicles are equipped with the Ford 390 cu. in. V8, and averaged 120 miles/day. Between November 1971 and June 1972 they travelled 20-25,000 miles apiece.

[1]Ford Motor Co., Transportation Planning Office, "Report on the Columbus, Ohio Model Cities Second Year Transit Project," 1972.

Findings - The brakes proved to be too small for the vehicle, generated excessive heat and displayed very short lining life. The electrical system, including the lights and the air conditioner did not operate properly. A larger alternator was installed in an attempt to solve the latter problem.

3. Racine, Wisconsin - One of the earlier purchasers of the Flxettes was the Flash Cab Company of Racine, Wisconsin which took over that city's transit service in September 1968. They now use ten 1968 model Flxettes and three 1969 models. These vehicles provide jitney style fixed route service on a 10 route system (i.e., they stop for hailers and let people off anywhere along a route). The fleet carries an average of 3,000 persons per day in a city of approximately 100,000.

The vehicles seat 19 persons and are equipped with a 6 cylinder Ford engine. The buses average 145 miles per day each and have up to 350,000 miles on them.

Findings - The vehicles all had severe brake problems at first, and Ford rebuilt all of the brakes. Brake linings are now being replaced at approximately every 15,000 miles. There have been no chassis or body replacements. Transmissions and engines have been replaced at approximately 100,000 mile intervals.

4. Regina, Saskatchewan - The Regina Transit Authority uses four Flxetees for "Telebus" service. These have been in service for slightly over a year and have 60,000 miles on them, travelling up to 150 miles per day.

Findings - The brakes have caused problems and have had to be replaced at 8,000 mile intervals.

- The heating system has not been sufficient for the vehicles.
- The engine compartment has proven to be very inconvenient for servicing.
- Body problems are beginning to develop.
- Fuel mileage has been about 8 miles per gallon.

GRUMMAN

The Grumman Aerospace Company entered the bus manufacturing business about three years ago. Currently the bus distribution is being handled by Thomas Bus Sales of Dansville, New York. The vehicles are manufactured in Montgomery, Pennsylvania.

The Grumman bus is built on a motor home chassis. The body utilizes some of the features of the trucks and motor homes produced by Grumman, but essentially the vehicle has been designed separately as a small bus.

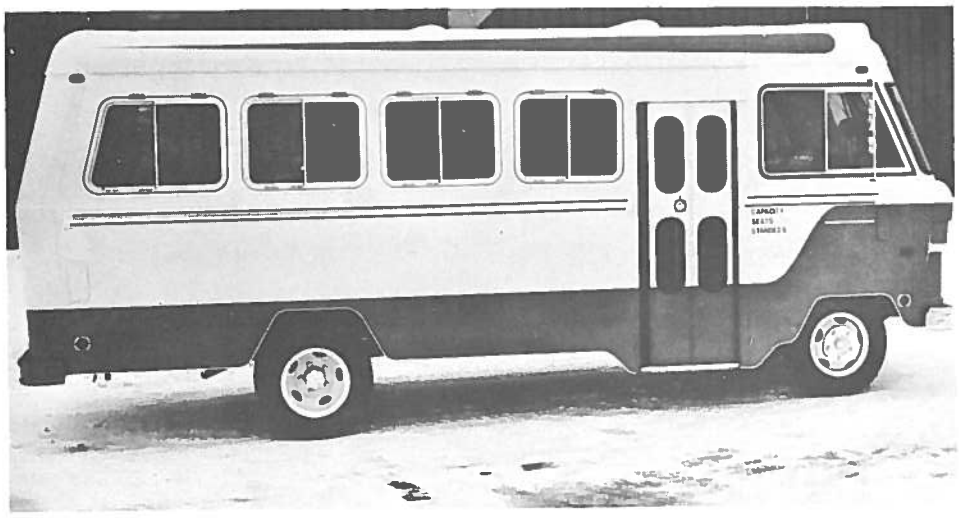

Figure 13. Grumman - Exterior View

GENERAL DESCRIPTION

The vehicle can be ordered with either a Ford, Chevrolet, or Dodge chassis. A number of optional gasoline engines are available, ranging from 350 to 454 cubic inches. Conversion to propane operation is also available. The bodies are made of alumninum, which contributes to a lower overall weight, and possibly to a longer body life.

Two versions of the vehicle are currently available, one seating 17-19 passengers, and one seating 23-25. The larger model is placed on a larger Dodge motor home chassis. Base prices for these vehicles are $15,600 and $18,000 respectively. There are plans to develop a diesel version of the larger vehicle, but so far that vehicle has not been built.

Only 11 units had been placed in operation as of March, 1974. All existing units were built on a Chevrolet chassis. Currently, the heavier Dodge chassis is being recommended by the distributor as more suitable for a transit operation. The vehicles that were sold cost about $12,000 each and all had 1972 bodies placed on 1970 chasses.

Grumman has sold a number of their newer units, including eight to Salem, Oregon, scheduled to begin providing DRT service in April 1974, and one to Rochester, New York, scheduled to be placed into "PERT" service in September 1974.

A hydraulic wheelchair lift is available as is air conditioning. Delivery delay is estimated at three months.

OPERATING EXPERIENCE

1. Buffalo, New York - Three Grumman 17 passenger vehicles were placed into operation in the Buffalo Model Cities area in late 1972. The vehicles had 1972 bodies mounted on 1970 Chevrolet chassis and were powered by 350 cu. in. V8 engines. The vehicles have since accumulated 15-20,000 miles.

Findings - Each vehicle has been off the road for 4-6 months because of brake failures. Chevrolet is rebuilding the brake system of all of the vehicles.

Other maintenance problems have been fairly minor.

2. Chemung County - The Chemung County Transit Authority uses two Grumman vehicles on a fixed route operation that has been running for less than a year. The vehicles are similar to the ones used in Grand Rapids and Buffalo with the exception that they were demonstrator models before their purchase.

Findings - As yet there have been no brake problems. However, there has been extensive minor maintenance. In particular, the engines have either been losing oil or burning it extremely quickly.

Fuel mileage has averaged below five miles per gallon.

3. Grand Rapids, Michigan - The Grand Rapids Transportation Authority received five vehicles in June 1973 to provide DRT service. The vehicles are 17 passenger models and cost $11,400.

Findings - Vehicles have been out of service for substantial amounts of time because of brake problems. Once again, Grumman and Chevrolet were combining to try to solve the problem. Despite the lower weight aluminum bodies, the weight of the vehicle has proven to be too great for the chassis and as a result a number of axles have been bent.

MERCEDES-BENZ

Mercedes-Benz has been selling small buses in the United States for over three years.

Figure.14. Mercedes-Benz - Exterior View

GENERAL DESCRIPTION

The Mercedes model 0309D is made entirely by Mercedes; body, chassis and engine included. Standard seating arrangements can accomodate up to 23 persons.

The vehicle is powered by a front mounted diesel engine. Mercedes claims upwards to 15 mpg on vehicles equipped with automatic transmission. Contact with operators has tended to verify this claim.

Standard versions of the vehicle have an interior headroom of only 68". A rasied 74" option is now available, but only on vehicles not equipped with air conditioning. The distributor says that

the raised roof will be available with air conditioned vehicles by summer 1974. Automatic transmission is another fairly new option. Lack of automatic transmission in the past made the vehicle less popular for operation in the United States.

The price of the Mercedes has increased dramatically in the last two years primarily as a consequence of the devaluation of the dollar. The base vehicle costs between $23,000 and $25,000, depending in part on the seating arrangement.

The distributor prefers not to release a complete user list. An abbreviated list reveals that there are at least 60 vehicles in transit use in 10 cities, with another 25-30 vehicles used in various shuttle operations.

One major concern noted by some users is the high interior noise level. Mercedes plans to provide better insulation for the engine compartment.

Wheelchair lifts are available, but are not installed by the manufacturer. Conversion costs about $5,000.

Delivery delay is about 6 months for the standard vehicle and longer if any special options are ordered.

OPERATIONAL EXPERIENCE

1. Morgantown, West Virginia - The Morgantown County Transit System began operating a fixed route bus system with five Mercedes vehicles about 18 months ago and now carries about 450 persons per day. The vehicles which originally had a seating capacity of 16 have had the seating capacity increased to 20 by the installation of perimeter seating. Total vehicle mileage varies from vehicle to vehicle. Two have about 20,000 miles, and the other three 35,000, 40,000, and 45,000 miles respectively.

Findings - Thus far there have been no breakdowns and no major maintenance problems. The vehicles are equipped with standard transmissions, but there have been no clutch problems. Brakes have been relined at 35,000 miles. Tires have been replaced in only one vehicle, at 45,000 miles.

Despite the fact that Morgantown is very hilly, the vehicles have averaged 12-13 miles per gallon of diesel fuel.

2. Bramalea, Ontario - Three Mercedes vehicles were introduced in the township of Bramalea, Ontario in September 1973 to provide DRT service. The buses seat 17 passengers and are equipped with manual transmissions. The vehicles average over 150 miles per day. Each vehicle has recorded approximately 24,000 miles to date.

Findings - Clutches have just been replaced in two of the vehicles. One transmission has also been replaced. The vehicles operated very well until cold weather set in. At that point there were severe problems in starting the vehicles and there were numerous fuel line freeze ups. (It should be pointed out that the vehicles are all parked out of doors.)

Brakes have not caused serious problems but have had to be replaced at 12-14,000 mile intervals.

The vehicles averaged 15 miles per gallon in the fall and 12 miles per gallon in the winter.

3. Haddonfield, New Jersey - Seven Mercedes were placed on Dial-a-Ride service in 1973. (Six in January, one in December.) The vehicles are equipped with standard transmissions. They originally had 16 seats, but the seating capacity was reduced to 10 to alleviate crowding conditions. The vehicles each average about 200 miles/day and each have a total of approximately 30,000 miles.

Findings - Problems have been fairly minor. Two clutches have been replaced. Brake linings have lasted an average of 12-15,000 miles. Two exhaust manifolds cracked, but Mercedes has since corrected the defect that caused the cracking.

The operator has received passenger complaints about the low headroom.

MINIBUS

Minibus, Inc. designs and manufactures a number of small vehicles. The vehicle of most interest for the purposes of this report is an 18 to 23 passenger transit vehicle. A special version of that vehicle is built with provisions for the handicapped. Minibus also builds vehicle trains for use in parks and airports and does custom design work.

Figure 15. Minibus - Exterior View

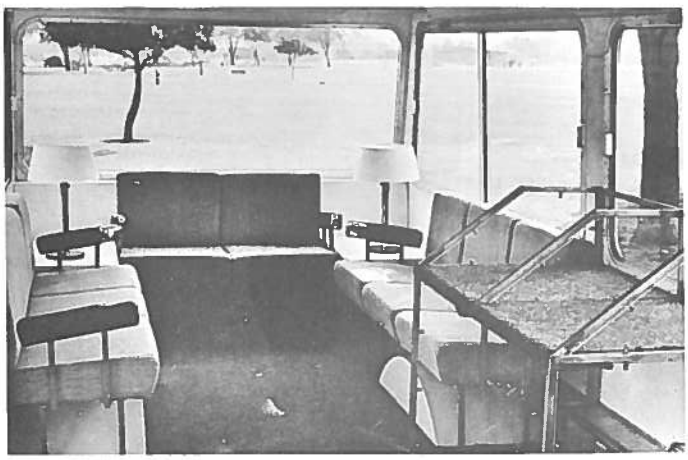

Figure 16. Minibus - Interior View

GENERAL DESCRIPTION

The Minibus Model MBS is the basic transit vehicle. It is now constructed utilizing an integrated frame and chassis designed by Minibus. Earlier models used a Chrysler chassis. Problems with that design prompted change, but most available information is on the older models. A gasoline engine is standard, but a diesel engine is available. The vehicle can be converted to propane or natural gas operation.

The "Handicap Vehicle" seats 16 and has room for four wheelchairs. It has a hydraulically operated side lift and a folding ramp at the rear of the vehicle. This ramp serves as a manual backup in case of failure of the hydraulic lift.

Basic cost of the MBS is $30,000-35,000. The version for handicapped persons sells for an additional $7,000. Fifty to sixty Minibuses are in use in transit applications throughout the country. About another 30 are used for various shuttle operations.

The Minibus train is essentially a modified Minibus combined with a number of non-powered trailers. These vehicles, with various body configurations are in use in National Parks, airports, and amusement parks.

OPERATING EXPERIENCE

1. Detroit, Michigan - The Department of Street Railways, Detroit, Michigan obtained six Minibuses in 1969 for use on a speical bus loop.[1] The vehicles are mounted on a Dodge chassis and have the Chrysler V8 engine. Over the five year period since they were purchased they have accumulated 48,000 to 80,000 miles.

Findings - The brakes have had an average life of 13,000 miles. Four engines have already been replaced with an average life of 60,000 miles. The transmissions have all been replaced.

[1] Proceedings of the Mechanical Division Session; ATA Annual Meeting, October 1973.

A variety of parts, such as the axles, king pins, drive shaft, and bushings have had to be replaced a few times. The body in general has caused problems as there have been leaking roofs and body panels that have had to be replaced. The buses have experienced an inordinate amount of down time in the operator's opinion.

The operator noted a serious problem in obtaining parts.

The Minibuses have averaged 4.1 miles per gallon.

2. Los Angeles, California - The Southern California Rapid Transit District received 19 Minibuses in October 1971 to operate on a 9.8 mile bi-directional loop serving downtown Los Angeles. The vehicles operate from 9 am-4 pm six days a week, and carry an average of 30,000 passengers per week.

The vehicles use a unique dual fuel system, with compressed natural gas (rather than liquified natural gas, which is generally used but is unavailable in Los Angeles) serving as the main fuel, and gasoline as a backup. The natural gas tanks provide the necessary range for one day of operation (except for vehicles which are used in park-and-ride shuttle service and travel greater distances).

Findings - The switch from natural gas to gasoline can be made while the vehicle is in operation, but the switch has created stalling problems. Consequently, there have been serious problems with the starters. The dual fuel system has also resulted in poor fuel mileage and extensive overheating. Large radiators were installed to counteract the latter problem.

A special disc brake was designed for the vehicle. Nevertheless, the brakes have had problems including short brake pad life. Service is needed at 6,000 mile intervals.

Another major problem since solved involved unreliable rear door operation. This was blamed on the flexing of the body, which caused movement in the door support and frame.

3. Hertz Corporation - Logan Airport - Hertz uses the minibus in airport shuttle services at a number of locations throughout the country. Hertz at Logan Airport in Boston has had two 19 passenger

Minibuses since May, 1972. The buses are used to shuttle people between the Hertz Rent-a-Car office and the airline terminals. The vehicles average 20,000 miles/year.

Findings - The vehicles have held up well, with no major maintenance problem. Complaints have centered around the heating and air conditioning systems which lack sufficient power for the size of the vehicle.

4. National Parks Service - Yosemite Park - Propane-powered Minibus Trains have been used in Yosemite Park for three years. Heavy pollution and traffic congestion within the Park prompted the Parks Service to ban traffic on major roads within the Park and provide a free, fixed-route shuttle service in its place.

Findings - To date the vehicles have performed well, with no problems with the propane power plant.

TWIN COACH - TC-25

Twin Coach began producing two sizes of small buses about four years ago. The TC-25 is 25 feet long and seats up to 25 passengers, while the TC-31 is about 28 feet long and seats up to 31 passengers. With the exception of size, the two vehicles are essentially identical, and since a 25 passenger limit is assumed in this study, only the TC-25 will be considered.

Figure 17. Twin Coach TC-25 - Exterior View

GENERAL DESCRIPTION

The TC-25 is not constructed with a body on chassis, but is designed with unitized, integral construction. It can be powered by either a gasoline, diesel, propane, or natural gas engine. A four speed automatic Allison transmission is now standard on all models, replacing the three speed Chrysler automatic which was used

originally. This change, as well as a number of others, was prompted by customer complaints. Other changes include:

(1) Air suspension is now standard, replacing the spring suspension.

(2) Brakes are now larger - 628 square inches of lining as opposed to 502.

The basic, gasoline-powered vehicle costs approximately $29,000. Approximate prices for popular options are:

Diesel Engine	$3,000
Air Conditioning	$2,000
Wheelchair lift	$5,000
Extended lower front step	$4,000
Wheelchair ramp	$1,000

The latter options are designed for the elderly and handicapped. These modifications were designed specifically for the demand responsive transportation system in the Naugatuck Valley, Connecticut.

As of January, 1974, approximately 120 TC-25's were in transit applications throughout the country. (There are a few being used as university shuttles or other such applications.) There are a number of TC-31's and earlier model TC-29's and suburban versions of the TC-25's in use as well. The first version of the TC-25 as it is now available was sold to the New Jersey Department of Transportation for the Haddonfield Dial-a-Ride program in January 1972.

Production capacity is currently one per day. As orders for the vehicle have grown, delivery delay has continued to increase. Current delay is estimated at eight to nine months for the standard vehicle. Special options, such as the wheelchair lift, can create a delay as long as one year.

Fort Lauderdale, Florida, with 45 Transit Coach vehicles has the largest fleet of TC-25's at present. Other large orders have since been received.

OPERATING EXPERIENCE

1. Haddonfield, New Jersey - Twelve TC-25's began providing Dial-a-Ride service in May 1972, in the Urban Mass Transportation Administration (UMTA) demonstration project. The vehicles seat 17 passengers in special angled perimeter seating. The vehicles have totalled approximately 100-110,000 miles.

Findings - Major issues identified by the operator include:

(1) Transmission shafts which snapped at an average of 43,000 miles on 10 buses.

(2) Radiators and oil pans which had to be raised because of bottoming.

(3) The air conditioning system which had batteries that were too small and improper wiring that caused burn-outs. The units have had to be rebuilt twice. The new system performs satisfactorily but has only been installed on half of the buses.

(4) The self-adjusters on the brake system which did not work properly, causing uneven lining wear.

(5) Some cracks and rusting which are appearing around the windows.

(6) Frequent breakings of U-bolts and fan belts.

2. Naugatuck Valley, Connecticut - The Valley Transit Authority received six gasoline-powered TC-25's in September 1972 for use in a DRT program directed primarily for the elderly and handicapped (vehicles are also used for charter and fixed route work). The system provides intra- and inter-town transportation for four adjacent towns in the Naugatuck Valley area of Connecticut.

All six of the vehicles are equipped with a wider front door, extendable steps and hand rails to make them more accessible for the elderly and mobile handicapped. However, the lower step, which is located below the floor of the vehicle, has on occasion hit the ground or curb causing damage to the mechanism. One of

the vehicles is also equipped with a hydraulic lift mounted midway on the vehicle. Space for locking in three wheelchairs was provided inside the vehicle, reducing the seating capacity to 15.

Findings - The biggest mechanical problem thus far has been the brakes. The brakes were underadjusting, and an attempt to correct that problem resulted in overadjusting which in turn ruined a number of brake drums.

The vehicles were equipped with the Chrysler 3 speed automatic transmissions which were found to have insufficient cooling capacity in the summer. As a result the transmission fluid has boiled on a number of occasions causing excessive stalling.

The area in which the vehicle operates is extremely hilly. The large rear over-hang plus the unequal weight distribution caused by a rear mounted engine has created a severe bottoming problem. Front water bumpers have compensated a bit for the extra rear weight, but not adequately. The vehicles are equipped with a spring suspension.

Other mechanical problems include breaking fan belts and air line and fuel line freeze-ups in winter.

3. Lansing, Michigan - Lansing, Michigan, received nine TC-25's in May of 1973 for use in a fixed-route bus system. All of the vehicles were down in March 1974, and most had been down for up to six months.

Findings - The operator has outlined a number of troublesome areas they encountered with the vehicles. Among them are:

(1) Numerous engine mounts have broken.

(2) Rivets have popped and skins fractured.

(3) Shock absorbers have broken off in all vehicles.

(4) Transmissions have burned out.

The vehicles have gasoline engines converted for propane operation. The operator feels that something in the fuel tank, probably carbon deposits, has combined with the propane to clog up

the engine governor. Because of this, and because of the special fueling requirement, the vehicles will be converted back to gasoline.

4. Rochester, New York - The Rochester-Genesee Regional Transportation Authority received seven TC-25's in July 1973, to be used for their PERsonal Transit (PERT) service. The vehicles seat 25, are equipped with the optional diesel engine, air suspension, and air conditioning. Approximate cost was $31,000 per vehicle. Delivery delay at that time was three to four months.

The vehicles have been averaging 150-160 miles per day, and each had a total of 18,000-22,000 miles by March 1974.

Findings - Until the onset of winter, there were no major mechanical problems. There were a number of minor problems, however. Fan belts kept breaking, as did U-bolts. The transmissions were very rough and have all been periodically adjusted. In addition, there were problems with some of the air conditioning units during the summer.

Five of the buses are kept outdoors. When the temperature fell below 15 degrees serious difficulty was encountered in starting the vehicles. Fuel lines froze as the vehicles were in operation.

There have been no brake problems whatsoever. Extra-size brake linings were ordered before they became standard. Fuel mileage has been good, averaging 7-7.5 miles per gallon. Fuel costs increased from 3.2 to 4.4¢ per mile with the increase in the cost of diesel fuel.

A number of negative comments have been received from passengers dealing with noise. Decibel readings show the vehicles not to be noisier than regular buses, but public expectations of smaller vehicles may cause the vehicles to seem noisier. Other complaints centered around the rough down shifting, a problem that seems to have been solved.

An on-board survey conducted by the consultants to the PERT project asked one question on the vehicle. Based on a 1 (poor) to 3 (excellent) scale, passengers reactions to the vehicle characteristics were as follows:

Appearance - 2.7

Comfort - 2.8

Noise - 2.0

The operator credits an extensive preventive maintenance program with keeping the vehicles as problem-free as they have been.

5. Worcester, Massachusetts - The Worcester Bus Company placed five 17 passenger Twin Coach vehicles on regular fixed-route service in November 1972. The vehicles have a gasoline engine and four speed transmission. They currently average 115 miles per day; all of the vehicles have recorded less than 30,000 miles.

Findings - One engine has had to be rebuilt as a result of a blown camshaft. Otherwise, the vehicles have operated fairly well, with the exception of some minor transmission problems. The brakes have had only slight problems with the automatic adjustment. During the winter, a number of starters have had to be replaced, even though the vehicles are garaged indoors.

Fuel mileage has averaged 4-3/4 miles per gallon.

DISCUSSION

As noted before, the manufacturer has been fairly responsive to complaints and suggestions of TC-25 operators. A number of changes have been made in the design of the vehicle, and changes are continuing. The differences from bus to bus in a single order have made at least one operator suggest that many of the problems may have resulted from poor quality control. The manufacturer has indicated a willingness to correct that situation, and to adapt its vehicle to meet the needs of the customers.

3.2.2 Electrically Powered Vehicles

Two manufacturers are currently marketing vehicles utilizing a battery powered electric motor rather than the more conventional internal combustion engine. The major problem with the use of electric vehicles, aside from debugging problems common to all new developments, is the short cruising range. This will continue to be a problem until there is a breakthrough in battery design. To overcome this problem the manufacturers have made the battery exchanging procedure extremely quick and recommend that at least two batteries be purchased.

The energy crisis and environmental concerns have made the concept of an electrically powered transit vehicle extremely popular, even though this vehicle class is still in its infancy.

Electric vehicles are not new, having been in use since the early part of the century. The introduction of these two buses is actually a renewed attempt to develop a broad market. Electric buses have been manufactured and used in Europe for a number of years.

BATTRONIC

Battronic was the first electric, battery powered transit vehicle available for use in the United States. It is manufactured by the Battronic Truck Corp., a subsidiary of the Boyertown Auto Body Works of Boyertown, Pennsylvania. Two different sized buses have been designed, seating 10 or 15. Both vehicles are essentially conversions of previously manufactured electric utility vans.

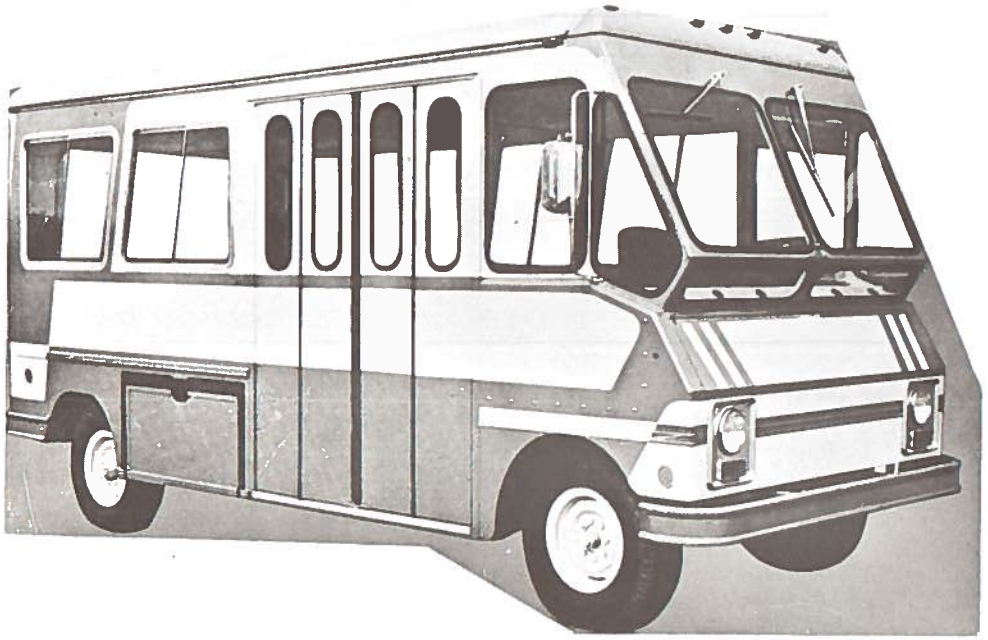

Figure 18. Battronic - Exterior View

GENERAL DESCRIPTION

The vehicles have an aluminum body mounted on a Boyertown designed truck chassis and are equipped with a General Electric series wound DC motor which produces a maximum of 6000 RPM and is powered by a 112 volt battery. The transmission is single speed.

The major difference between the smaller and larger vehicles is size. The 10 passenger vehicle is mounted on a 111" wheel base chassis, with a front axle capacity of 3800 lbs. and rear axle capacities of 4700 and 7800 lbs. respectively. The large vehicle also has larger tires, but the same size brakes.

The electric vehicle operates in a similar manner to traditional gasoline or diesel powered vehicles, at least from the point of view of the driver controls. The major problem with an electric propulsion system, and the problem that has kept them from general use in the past, is cruising range. Range is entirely a function of battery storage capacity. The manufacturer claims a range of about 40 miles on one battery charge, and a top speed of about 30 mph. Batteries can be changed in under 15 minutes so that theoretically the vehicle can be kept in more or less constant use.

The 10 passenger bus sells for about $15,000, plus $3,000 for each battery. The larger vehicle costs $28,000, plus $3,000 for each battery.

Seven vehicles are in transit use in the country, one in Merrill, Wisconsin providing demand responsive transportation for the elderly, and six in Lansing, Michigan operating a shuttle service. Another vehicle is used by the Cleveland Electric Co. No additional vehicles have been ordered, and none are on the assembly line.

OPERATING EXPERIENCE

1. Lansing, Michigan - The Capital Transit Authority placed six Battronic 15 passenger buses on a shuttle service during the summer of 1973.

Findings - All six of the vehicles have been out of operation since September. There have been many problems with the electrical system involving short circuits that affected lights and instruments as well as the motor. There has been a continuing problem with the vehicle stalling. Once the vehicles stalled it was difficult to start them again.

The propane heating system became a problem when it did not conform to requirements of the city fire marshall.

The vehicles were found to have had a maximum range of 25 miles, well below the rated range.

DISCUSSION

The manufacturer has been involved in a continuous debugging process and claims that the vehicles are operating in a different environment than they were supposed to have been. They were supposed to operate on an automobile-free route, and instead have been operating in traffic. The manufacturer feels that most of the problems stem from the fact that the vehicles were operating at much lower than designed speed. The operator does admit this, but states that problems began with the vehicles during the first day of operation.

ELECTROBUS

Electrobus is the second entry into the electric-powered small bus market. It is produced by the Tork-Link Corporation, recently purchased by Otis Elevator Company.

Figure 19. Electrobus - Exterior View

Figure 20. Electrobus - Interior View

GENERAL DESCRIPTION

Electrobus is powered by a large DC series wound electric traction motor, designed especially for the bus by the company. The motor is connected directly to the rear axle without the use of clutches, gears or transmission. It is rated at 125 horsepower and operates from a 36 cell lead acid traction battery which weighs about 3400 lbs. Maximum armature speed is 5500 rpm.

Driver controls are basically the same as in a standard vehicle; i.e., there is a steering wheel, and brake and accelerator pedals. The gear shift is replaced by a Forward-Reverse-Off switch.

The vehicle has been designed from the ground up as a bus. The chassis and body are both designed by Tork-Link. The body of the bus has an aluminum outer skin.

There are two versions of the small bus: Model 20 seats 20, and Model 26 seats up to 30. (Electrobus Model 50 seats 50 passengers.)

The base price of the Model 20 is $28,000. The battery rack and charger, which are necessary, cost $2700. The batteries cost $5200 each. A fork lift, used to lift the battery into position is available and sells for $5500.

Batteries are estimated to have a 60,000 mile life.

DISCUSSION

A unique feature of this vehicle is the braking system. The brake system is connected to the motor in such a manner that the motor acts as a generator during braking. This action provides a retarding power to the vehicle's movement. The greater the speed the greater the retarding power, and the less brake effort is necessary. This should result, according to the manufacturer, in greater brake lining life and better braking characteristics.

As of March 1974 no Electrobus vehicles have been placed into service. Three buses are scheduled to be put into fixed-route operation in Long Beach, California by late winter; one bus is scheduled for delivery to Welfare Island in New York City; one is

scheduled for Con Edison in New York City for use on an employee shuttle; and one bus is on order for the Rochester, New York PERT service and scheduled for a July delivery. A number of other orders are pending. Estimated delivery delay is about 5-6 months.

The manufacturer claims a top speed of 35 miles per hour and a range of about 40 miles or 3-5 hours. Battery exchange is supposed to take less than 15 minutes. Batteries recharge in about 4 hours.

A prototype of the vehicle has been put through various tests throughout the country. One test in Long Beach, Long Island indicated that the vehicle in fact has about a 50 mile range. The vehicle travelled 38 miles in heavy traffic, and tests showed the battery to be only 65% discharged.

Tests on Long Island and similar tests in California attempted to determine the vehicle's "fuel mileage equivalent", i.e., the distance it could travel on one gallon of fossil fuel (which would be used to generate electricity). Model 20 averaged 11.5 miles in Long Island and 12 miles in California, while Model 26 averaged 10 miles in California. Using data from Pacific Gas and Electric Company on the amount of power used to convert fossil fuel to electricity, Electrobus estimates that the equivalent fuel mileage of a small gasoline or diesel powered vehicle (the distance travelled per gallon of fossil fuel) is about 3.5-5.0 miles per gallon.

3.3 CONVERTED MOTOR HOMES

A motor home consists of a body mounted on a truck chassis, the same design concept used for a number of small transit vehicles. Small buses such as the Grumman share a number of components, including the chassis, with a Grumman manufactured motor home. Since most motor homes are about the same size as a small transit vehicle it is perhaps not surprising that a number of small transit vehicles now being marketed are in fact converted motor homes.

The simplest conversion of a motor home would involve no more than the installation of passenger seats. On the other hand, to convert a motor home to a transit vehicle could involve significant

changes to the suspension, brakes, or other mechanical components.

The first modified motor home, the (RekVee) Club Car, was placed in transit service in Canada in September 1973. Since then the fuel crisis has encouraged a number of motor home manufacturers to introduce small transit vehicles based on a modified motor home. At the time of the writing of this report none of these other vehicles had yet been used for any transit application.

AIRSTREAM, ARGOSY COMPACT BUS

Airstream has recently introduced a small transit vehicle based on their Argosy motor home.

Figure 21. Argosy Compact Bus - Exterior View

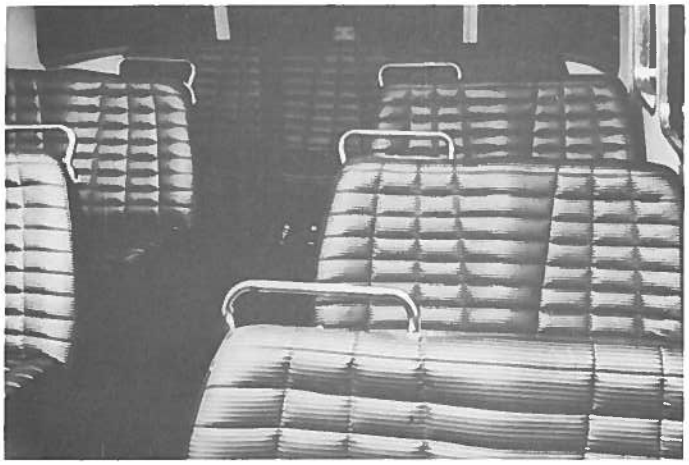

Figure 22. Argosy Compact Bus - Interior View

GENERAL DESCRIPTION

The bus is 240" long and has a capacity of 15 seated passengers. The vehicle is designed and equipped to meet the California Code Requirements for a Class II bus. The body is mounted on a Chevrolet (Model CP 31432) chassis and is powered by a 350 cu. in. V8 engine. A Turbo hydramatic transmission is standard equipment.

The price of the vehicle is $12,546; delivery is expected to take 6-8 weeks.

None of the vehicles have been placed in operation as yet.

APECO MRB

The Apeco MRB (Middle Range Bus) was placed on the small bus market within the past few months.

Figure 23. Apeco MRB - Exterior View

GENERAL DESCRIPTION

The bus is 264" long, 93" wide, and has a 145" wheel base. It is mounted on a Dodge RM 350 chassis and is powered by a 360 cubic inch V8 engine.

The motor home has been designed with a separate cab. Because of that design the wall between the cab and the remainder of the vehicle cannot be totally removed. Thus, if this vehicle is used in transit application there could be problems with the location of the fare box and the driver could have difficulty interacting with the passengers.

The major modification of this motor home is a redesigned interior and the inclusion of windows in the body. A special driver operated passenger door is also provided.

Base price of the vehicle is about $13,000, and delivery delay is about 8-10 weeks.

None of the vehicles have been placed in operation.

FMC CORPORATION

The Recreational Vehicle Division of the FMC Corporation has recently introduced a small transit vehicle based on their motor home which is considered one of the most luxurious on the market.

Figure 24. FMC Coach - Exterior View

Figure 25. FMC Coach - Interior View

GENERAL DESCRIPTION

The bus is 30 feet long and can seat up to 27 passengers. It has a rear mounted engine. A choice of gasoline (Chrysler 1440), diesel (Detroit diesel), or propane engine (Chrysler H440) is available. A 3 speed Chrysler automatic transmission is standard, and a 4 speed Allison automatic transmission is optional. Twelve ply Michelin tires are standard.

The base price of the vehicle is $30,000-$35,000; delivery delay may be up to six months. A special vehicle for the handicapped is being designed.

None of the vehicles have been placed in operation.

PACE ARROW PEOPLE MOVER

Pace Arrow, a subsidiary of Fleetwood Enterprises, recently introduced a small vehicle based on a converted motor home.

Seating capacity ranges from 3 to 15. Pace Arrow does not actually label the vehicle as a transit vehicle, but advertises it as a family vehicle or passenger vehicle for car pools, hotel shuttles, etc.

Figure 26. Pace Arrow People Mover - Exterior View

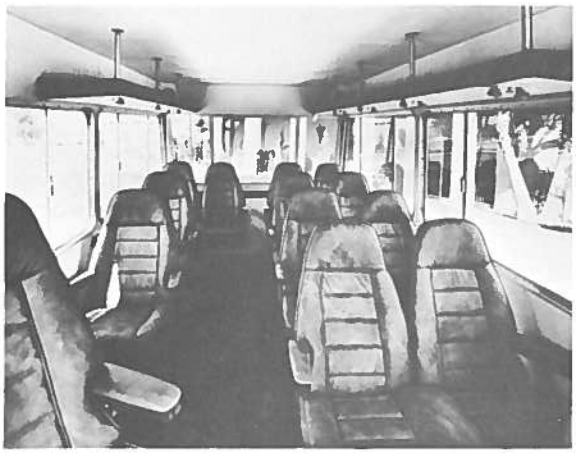

Figure 27. Pace Arrow People Mover - Interior View

GENERAL DESCRIPTION

The vehicle is built on a Dodge Motor Home Chassis with dual rear wheels, is 20' long, and is powered by a Dodge 318 V8 engine.

Base price ranges from $7,500 to $8,500.

As with the other vehicles of its type none have as yet been placed into service.

REK VEE CLUB CAR

The Ontario Transportation Development Corporation (OTDC) was established by the Ontario Ministry of Transportation and Communications to help develop better public transit service. The development of a suitable demand responsive transportation vehicle became the major part of the overall OTDC program. They set out to develop a proper vehicle over a number of phases. The first phase involved the development of a suitable vehicle for immediate use. The result of the first phase is the Club Car, a remodeled motor home, with a body by Rek Vee of Scarborough, Ontario and a Dodge motor home chassis. (The interior furnishings of the bus are by Funcraft of Cambridge, Ontario, who have been involved with other Canadian vehicle modifications.) The interiors are designed to be extremely plush; hence the name Club Car.

The Club Car can perhaps be considered the forerunner of the current rush to transform a motor home into a small transit vehicle. This vehicle, however, was developed by a transit group rather than by a motor home manufacturer, and was developed for the express purpose of acting as a suitable vehicle for a demand responsive transportation system. Rek Vee, the manufacturer of the motor home converted into the Club Car, serves only as a contractor and as such has not been responsible for marketing the vehicle.

Figure 28. REK VEE Club Car - Exterior View

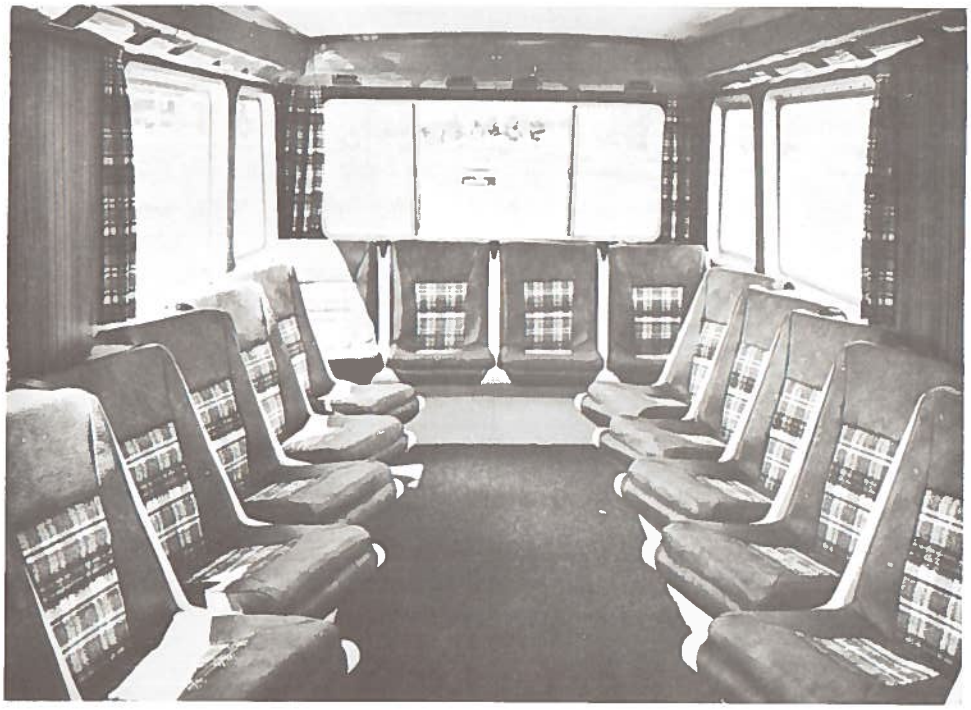

Figure 29. REK VEE Club Car - Interior View

GENERAL DESCRIPTION

The vehicle is mounted on a Dodge RM-400 motor home chassis, which is considered the strongest such chassis available. The engine is a Chrysler 440 cu. in. V8 and is coupled with a Chrysler 3 speed automatic transmission.

The body is made out of fiberglass (or more correctly FRP, for fiberglass-reinforced plastic). Advantages of a fiberglass body are: lighter weight for better gasoline mileage and better maneuverability, and no rusting for better body appearance. It remains to be seen how well a fiberglass body will hold up in any collision. Repairs of fiberglass in the case of damage can be fairly expensive.

About 80 Club Cars have been ordered, primarily within Ontario. The first two vehicles for use in the United States have recently been ordered for the Rochester, N.Y. PERT system. Only about 25 vehicles have been put in service. Vehicles are currently in use in Toronto, Ottawa, Burlington, and Cambridge, all in Ontario.

OTDC concedes that the Club Car's truck chassis may not be suitable for transit operation. They are in the process of developing a longer life chassis, and feel that they will be able to transfer current bodies to the newer chassis. They are also working on modifying the vehicle to make it more suitable for the elderly and handicapped. In addition, OTDC is working on plans for a hybrid gas-powered/electric-powered vehicle. Although they are working on developing a long life chassis they suggest the possibility that it may, in fact, make more sense to continue to use relatively inexpensive "throw away" chassis than to develop and then use a much more expensive long life chassis.

The Club Car costs $20,000-$21,000. Air conditioning is not available. The vehicles are not actually being marketed since they are still considered experimental. However, they can be ordered by interested parties. Current estimated delivery delay is four to five months. If interest continues to grow as it has been, production capacity will be increased.

OPERATIONAL EXPERIENCE

1. Toronto, Ontario - Toronto received the first of the Club Cars for its DRT system in the summer of 1973. The vehicles have travelled 12-13,000 miles each.

Findings - The vehicles have thus far performed very well. Problems have been limited to minor electrical problems, some engine gasket problems and some transmission problems. None have been serious, and the transmission problems were all under warranty.

SUPERIOR COACH CONSERV-A-RIDE II

The Conserv-a-Ride II is another converted motor home developed by Superior Coach.

Figure 30. Conserv-a-Ride II - Exterior View

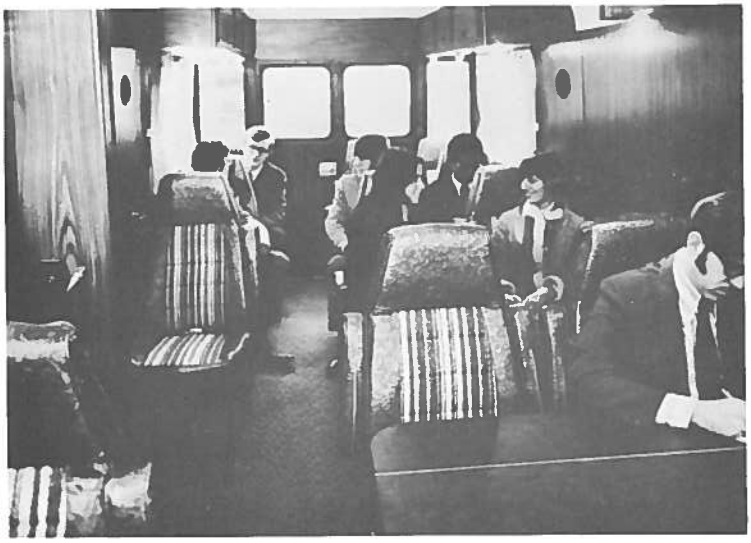

Figure 31. Conserv-a-Ride II - Interior View

GENERAL DESCRIPTION

There are actually three versions of this vehicle. Model 2000 seats up to 16 persons, is mounted on a Dodge RM-300 chassis with a Dodge 318 cu. in. V8 engine and is 22 feet long. Model 2200 seats up to 20, is mounted on a RM350 chassis, has the 318 engine, and is 22 feet long. Model 2500 seats up to 27 persons, is mounted on the Dodge RM-400 chassis, is powered by the Dodge 440 cu. in V8 engine, and is 25 feet long. (The largest engine is available on all models.)

The major modification made on this vehicle is to the interior and to the door operation. No additional windows have been added.

Model 2200 sells for $12,800; Models 2000 and 2500 are respectively slightly less and slightly more. Expected delivery delay is 8-10 weeks.

None of the vehicles have yet been placed into operation.

WINNEBAGO

Winnebago, the largest manufacturer of motor homes in the United States, entered the small bus market in late 1973 with their version of a converted motor home.

Figure 32. Winnebago - Exterior View

GENERAL DESCRIPTION

Their vehicle is 267" long; turning radius is 28 feet; weight is just under 8,000 lbs.; seating capacity is about 19. The vehicle is mounted on a Crysler RM-350 chassis and is powered by a Chrysler 440 cu. in. engine. The major change from the motor home design is the modification of the interior, plus the addition of windows to the body.

The bus costs approximately $12,000, air conditioning included. A wheelchair lift is being designed, but no cost has been set. Quoted delivery delay is about 2 months.

None of the vehicles have yet been placed into operation.

3.4 DISCONTINUED VEHICLES

A few small transit vehicle manufacturers have recently discontinued the production of their vehicle. Since a number of these vehicles are being used in some localities they will be discussed briefly.

GILLIG MICRO COACH

Gillig Transit Sales produced the Micro Coach until this year. There were three different sized models of the Micro Coach all mounted on a Ford Model P500 truck chassis and powered by a Ford 330 cu. in. V8 engine. About 20 vehicles were sold in California. The manufacturer (basically a school bus manufacturer) claims production was discontinued because of a lack of a national distribution capacity.

PREVOST TRAVELAIR

Prevost Car, Inc, of Dorchester, Canada formerly produced a 19-33 passenger gasoline powered vehicle called the Travelair. They now will do custom design but are not interested in competing in the small bus market. One custom designed vehicle is in use in Quebec City.

(A related company, Prevost in Perry, Georgia designs small bus chassis that are used for small school buses.)

UNIBUS

The Unibus, designed by Van Hool of Belgium, was distributed by the Unibus Corporation of Malton, Ontario until North American distribution was discontinued in 1973.

Only a few vehicles have been used in the United States. One serves as a shuttle vehicle at Kennedy Airport in New York. For use in North America all mechanical units had to be of North American Manufacture. The body is therefore mounted on a Ford Model M500 motor home chassis, and the bus is powered by a Ford 390 V8 engine.

OPERATING EXPERIENCE

1. Regina, Saskatchewan - Regina, Saskatchewan placed one 23 passenger Unibus on their Telebus service in early 1972. The bus has totalled 110,000 miles.

Findings - The engine, a Ford 390 was rebuilt at 107,000 miles. Brakes have been a serious problem, and have had to be replaced every 8,000 miles or so. The door has not operated properly. Some replacement parts for repair work were parts designed earlier than 1960, suggesting that the chassis might have been surplus equipment used by the bus manufacturer.

3.5 NEW VEHICLES

Now that the market for the small bus is expanding and the problems with many of the existing models are being discovered, a number of new vehicles are being designed or considered by several different manufacturers.

FLXIBLE CO. has plans to remove a 10 foot section from the mid-section of one of their large vehicles to produce a 30 passenger bus. Since the vehicle components will be those of a full size transit vehicle they feel that the small vehicle will operate just as well as a regular transit model.

FLYER INDUSTRIES of Winnipeg, Canada have been given a grant to develop a suitable small bus. They plan to introduce the vehicle in 1975.

Plans call for a 20-25 passenger bus to be designed from the ground up using unitized construction, air suspension and other characteristics found to be important for small bus operation.

GENERAL MOTORS has been talking about introducing a small bus version of their newest motor home for a number of years, but no introduction date is scheduled. The bus should have front wheel drive and an air suspension system.

They also plan to market a small 15 passenger vehicle based on a converted passenger van to be called the "Jetney People Carrier". They do not recommend the vehicle for transit use.

CHEVROLET is planning a bus based on a motor home chassis, but has delayed introduction.

THE ONTARIO TRANSPORTATION DEVELOPMENT CORPORATION, as noted earlier, is trying to develop both a long life small bus chassis and an electric/gas hybrid powered vehicle.

4. SUMMARY AND PERSPECTIVE

Why are Small Vehicles Used?

It is perhaps a popular misconception that the major reason for the use of small vehicles is one of economics; i.e., that smaller vehicles are more economical to operate than full size buses.

A considerable part of the cost of operating a vehicle is not a function of the vehicle itself. In most transit operations 50%-75% of the total vehicle operating cost consists of drivers' wages and benefits. Thus fuel and maintenance cost, which are dependent on the vehicle being used and which comprise the bulk of the remaining vehicle operating cost, account for at most half of the total cost. Most of the van type vehicles have achieved better fuel mileage than regular transit vehicles, but some of the other small buses have not. In addition, the maintenance problems encountered by many of the small vehicles have resulted, in general, in high maintenance costs. Thus some small vehicles may in fact be as costly to operate as a full size transit vehicle.

Lower capital cost of the smaller vehicles are a strong incentive for their use. But if yearly capital cost, (i.e., depreciation and interest charges) is considered the differences between different sized vehicles are not as great as one would expect. A full size bus may cost $50,000, but is designed to last up to 20 years and 1,000,000 miles. A converted van may cost $10,000, but last no more than three years and 150,000 miles. A small bus might cost $25,000, and last six years and 300,000 miles. If straight line depreciation and 8% financing with bonds were assumed yearly capital cost would be:

Full Size Bus	$6,500
Small Bus	6,200
Converted Van	4,100

Thus, while the full size bus is perhaps the most expensive the actual yearly capital cost differences of the three vehicles are not as significant as initial costs would indicate.

The major advantage of the small vehicle is not a function of economics, but rather of size. Their maneuverability allows them to operate in locations where larger vehicles could not operate. Their smaller size makes them less objectionable for use on residential streets. Their fresh appearance is often important in attracting passengers who might have negative feelings toward standard-size buses.

What Has Been the General Passenger and Driver Reaction?

Passenger reaction to most of the small vehicles seems to have been very similar. People find these vehicles a refreshing change from the large buses used in standard transit operations. They find most of the vehicles attractive and comfortable, which is not surprising since in almost all cases particular attention is given by both the manufacturer and operator to these amenities.

One major source of complaints has involved heating and air conditioning units. The heating and air conditioning of some of the vehicles are not sufficient for a transit operation. Another major complaint has been interior noise, particularly in vehicles with engines mounted in the rear, and in vehicles with diesel engines. The ride of smaller vans is often uncomfortable, a point noted particularly by the elderly. Low door clearance has also been a problem with some models.

Driver reaction seems to depend more on the type of vehicles the drivers had driven previously than on the small vehicle itself. Drivers who are used to driving larger vehicles like the handling and maneuverability of the smaller vehicles. On the other hand taxi drivers or others used to smaller vehicles are often dissatisfied with the larger vehicles.

In cases where the small buses have been very susceptable to breakdowns driver reaction has been particularly negative.

What Has Been The Overall Experience With Small Transit Vehicles?

None of the vehicles discussed in this report have been totally free of problems. No single vehicle or class of vehicle has proven itself to be clearly superior to any other.

Most of the problems experienced by operators of small vehicles stem from the fact that vehicles not designed specifically for transit operation have been placed into transit use.

Brake problems have been the most common type of problem experienced by small vehicles. Often the brakes used have not been large or powerful enough for stop and go transit operations. Also, many small buses use hydraulic rather than air brakes, resulting in faster brake wear.

Other common problems encountered include:

(1) Axles and U-bolts breaking or bending under heavy loads

(2) Short transmission life

(3) Air conditioning failure

Vehicles using unconventional power plants, propane and natural gas engines, or electric motors have yet to prove themselves applicable for transit operation.

What Changes Have Been Made in Small Vehicle Design?

As experience with small transit vehicles has grown, many manufacturers have responded by making a number of changes to their product. Among the changes:

(1) Seating arrangements in smaller vans are being changed to accomodate a greater number of passengers. Lack of passenger capacity has made a number of DRT systems switch to larger vehicles.

(2) For those vehicles utilizing body on chassis construction, stronger chassis are being used.

(3) There has been some shift in the direction of designing vehicles with unitized construction, rather than body on chassis.

(4) Brake lining area is being increased on many of the vehicles.

(5) Larger truck type engines have replaced smaller, automotive engines on some models.

(6) More rugged, non-automotive transmissions are being introduced.

(7) Air ride suspension systems like those used in full size transit vehicles are replacing standard spring suspensions.

Certain components are becoming popular with a number of manufacturers. For example the Allison heavy duty automatic transmission is being used more frequently. The Dodge motor home chassis has become a popular chassis for small vehicle design.

CONCLUSION

It has been noted that "no ideal small transit vehicles exist today."[1] Clearly the operational experience of the available vehicles tends to bear this out; no vehicle has been free of problems. No vehicle appears to be clearly better than all others, although certain vehicles are better for certain applications.

Since vehicle requirements vary from one location to another according to such factors as demand and service levels, geography, weather, economic conditions, maintenance arrangements, etc., the task of vehicle selection is not as straightforward as it might seem. Matching a vehicle fleet to the specific requirements of the service area is a choice of major importance especially in light of the fact that all vehicles have problems of some sort.

Until the recent increase in the demand for small vehicles arose there was no incentive for small bus manufacturers to try to develop a superior vehicle. General Motors, for example, got out of the small or medium size bus business (they had produced buses in the 30 passenger range), despite the fact that the GM buses

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[1] Swanson, Ronald, "Vehicle Equipment for Demand Responsive Systems," Demand Responsive Bus Conference Proceedings, 1972.

were clearly recognized as excellent vehicles, because there were not enough people willing to pay the fairly high price for a small bus.

The small transit vehicles discussed in this report have been in existence for only about seven years. Currently available vehicles are still responding to operational experiences. New vehicles which try to combine the best features of the other vehicles are being developed.

The differences between various types of small transit vehicles reflect a difference in philosophy. Companies involved in van conversions feel that the best and least expensive way to produce a suitable transit vehicle is to modify a mass produced vehicle. Other manufacturers feel that it makes more sense to place bodies on "throwaway" chassis that must be replaced every few years. Other suggestions have included shortening a full size vehicle, or refurbishing older small vehicles no longer in operation. Each of these viewpoints may have associated merits, advantages and disadvantages.

Now that the demand for small transit vehicles has begun to grow there has been a response from the manufacturers both in terms of an increase in the number and types of small vehicles available and in terms of improvements to the existing vehicles. If this response continues much improved small transit vehicles should be on the market sometime in the near future.

Major research projects sponsored by the U.S. Department of Transportation are also soon to begin on the specification and design of small transit and para-transit vehicles. The results of these efforts will undoubtedly affect this market in the future.

These combined public and private efforts should improve the quality of small transit vehicles. Users of these vehicles can, therefore, look forward to improved vehicle performance as experience and research combine to create superior designs and quality.

APPENDIX A

VEHICLE USER LIST

The majority of the information contained in the following listing was provided by the vehicle manufacturers or distributors. In several instances a complete list of users was not available. In a few cases no list at all was available and the authors relied upon their knowledge of locations in which these vehicles have been utilized.

The vehicle user list is arranged according to vehicle type in the same order as presented in Section 3 of this report.

Vehicle	City or Operator	Number in Use (and Application)
Dodge Van, Maxivan	Regina, Saskatchewan	6 - DRT
	Peabody, Massachusetts	2 - Elderly Transportation
	Bay Ridges, Ontario	5 - DRT
	Buffalo, New York	10 - DRT
	(Complete List Not Available)	
Ford: Econoline	Ann Arbor, Michigan	2 - DRT
Courier	Bay Ridges, Ontario	5 - DRT
	Rochester, New York	1 - DRT
	Ann Arbor, Michigan	1 - DRT
	Chemung County, New York	5 - Fixed Route
	(Complete List Not Available)	
Fortivan (Coach and Equipment Sales Corp.)	Transit Users:	
	Ann Arbor, Michigan	3 (11 on order)-DRT
	Oakville, Ontario	2 - DRT
	Bay Ridges, Ontario	5 - DRT
	Bramalea, Ontario	3 - DRT
	Marlboro, Massachusetts	1 - Elderly Transportation
	Middletown, Ohio	1
	Madison Heights, Michigan	1
	LaPort, Indiana	2
	Saginaw, Michigan	8
	Dover, Delaware	4
	Non-Transit Users:	
	Sparetime Travel, Inc. Canadigua, New York	1
	Kanakee Auto Leasing Kanakee, Illinois	1
	Paul Goldman Dodge, So. Attleboro, Mass.	1
	Jennings Car and Truck Rental, Mass.	3
	Chauffeured Cars Int'l. Illinois	8
	Ponderosa Steak House Michigan	1
	Rice and Holman, Inc. Pennsenkan, N.J.	1
	American Youth Hostels Illinois	2
	Congliana Motors, N.J.	1

Vehicle	City or Operator	Number in Use (and Application
Chevrolet Van Sportvan	Complete List Not Available	
Superior Conserv-A-Ride	Not Yet in Use	
Carpenter Cadet	Torrington, Connecticut (Complete List Not Available)	3 - Fixed Route Transit Service
Flxible Flxette	Transit Use: Mansfield, Ohio Fresno, California Topeka, Kansas Grove City, Ohio Ithaca, New York Suffolk, Virginia Parkersburg, West Virginia Clarksburg, West Virginia Racine, Wisconsin Aurora, Illinois Bloomington, Minnesota Elgin, Illinois New London, Connecticut Amarillo, Texas Manitowoc, Wisconsin Opelika, Alabama Steubenville, Ohio Marin City, California Graham, North Carolina Burlington, North Carolina North Olmsted, Ohio Washington, Pennsylvania Duluth, Minnesota Waianae, Hawaii Fairmont, West Virginia Palm Bay, Florida Pueblo, Colorado Hollywood, Florida Juneau, Alaska Carbondale, Illinois St. Paul, Minnesota Evansville, Indiana Columbus, Ohio Dallas, Texas Panama City, Florida Batavia, New York Laguna Beach, California Tallahassee, Florida Austin, Texas Englewood, Colorado Miami Beach, Florida	

Vehicle		City or Operator
Flxible	Flxette	Transit Use (Cont)
		Aliquippa, Pennsylvania
		Cranston, Rhode Island
		Columbia, Maryland
		Santa Ana, California
		Seattle, Washington
		Middletown, Ohio
		Ft. Lauderdale, Florida
		*New Orleans, Louisiana
		*Spring Valley, New York
		*Bensenville, Illinois
		*Albuquerque, New Mexico
		Regina, Saskatchewan
		Airport Service:
		*Valet Parking, Lambert Field St. Louis, Missouri
		Empire Cab Company Sudbury, Ontario
		Westminster Auto Motors Westminster, British Columbia
		Budget Rent A Car Atlanta, East Point, Georgia
		AirporTransit, Inc. Los Angeles, California
		Continental Air Transport Chicago, Illinois
		United Transportation, Inc. Columbus, Ohio
		Airport Limousine Service Indianapolis, Indiana
		Terminal Transportation Honolulu, Hawaii
		Jackson Municipal Airport Jackson, Mississippi
		Avis Rent A Car Schiller Park, Illinois
		Avis Rent A Car Jamaica, Long Island, New York
		Avis Rent A Car System, Inc. Garden City, New York
		Yellow Cab Company Biloxi, Mississippi
		Hausman Bus Sales Chicago, Illinois
		Kenton Co. Airport Bd., Greater Cincinnati Airport Cincinnati, Ohio
		*Greater Pittsburgh Airport Pittsburgh, Pennsylvania

*On Order

Vehicle	City or Operator	Number and Use (and Application)
Flxible Flxette	Sightseeing, Charter, Intercity	
	Studio Transportation, Inc. Hollywood, California	
	Haybran Enterprises, Inc. Tomball, Texas	
	Alexandria-Pineville Bus Company Alexandria, Louisiana	
	Blue Line Sightseeing Company, Inc. Washington, D.C.	
	Wells Bus Lines Batesville, Arkanasa	
	Private Industry, etc. (Cont)	
	McRae's Department Stores Jackson, Mississippi	
	U.A.W. International Detroit, Michigan	
	The University of Texas, M.D. Anderson Hospital Houston, Texas	
	Texas Medical Center Houston, Texas	
	Prevost Car, Inc. Ste-Claire (Dorchester), Q.C.	
	Golden Rain Foundation Walnut Creek, California	
	Franklin United Methodist Home Franklin, Indiana	
	Cedar Point, Ohio	
	Crystal City Marriott Hotel Alexandria, Virginia	
	*University of Chicago Chicago, Illinois	
Grumman	Grand Rapids, Michigan	5 - DRT
	Elmira, New York	2 - Fixed Route
	Buffalo, New York	3 - Elderly DRT
	William Bus Line, Buffalo, New York	3 - DRT
Mercedes 0903D	Transit Use:	
	Morgantown, W. Virginia	5 - Fixed Route
	New Orleans, La.	16
	Haddonfield, New Jersey	7 - DRT
	Stanton Rosa, Calif.	1
	Fairmont, W. Virginia	6
	Miami, Florida	6
	Bloomington, Indiana	9
	Jacksonville, Florida	5
	Niles, Illinois	6
	Bramalea, Ontario	3 - DRT

*On Order

Vehicle	City or Operator	Number and Use (and Application)
	Non-Transit Use:	
	Airway Equipment Rental South Ozone Park, N.Y.	
	Hershey Estates, Penn.	1
	Airport Shuttle, Inc. Wilmington, Delaware	5
	Monongalia County Court House, Morgantown, W. Va.	6
	Hertz Corp., Chicago, Ill., Alexandria, Va., N.Y., N.Y.	Total of 144
	Lorna Linda University	1
	Synanon Foundation (Complete List Not Available)	2
Minibus MBS	Detroit, Michigan	6
	Los Angeles, Calif.	19
	Logan Airport Boston, Mass. (Complete List Not Available)	2
Twin Coach TC-25	Transit Use:	
	Haddonfield, N.J.	12 - DRT
	Richmond, Indiana	10
	Salisbury, Maryland	4
	Denver, Colorado	10
	Helena, Montana	2
	Washington, D.C.	15 - Fixed Route
	Bridgeton, N.J.	1
	Worcester, Mass.	5 - Fixed Route
	Naugatuck Valley, Conn.	6 - DRT
	Boston, Mass	16 - Fixed Route
	Norwood, Ohio	2
	Lansing, Michigan	9 - Fixed Route
	Lafayette, Indiana	16
	Ottawa, Ontario	5 - DRT
	Rochester, N.Y.	7 - DRT
	Fort Lauderdale, Fla.	45
	Bakersfield, Calif.	1
	Middleton, Ohio	2
	Vail, Colorado	2
	East Chicago, Indiana	5
Battronic	Merrill, Wisconsin	1 - Elderly DRT
	Lansing, Michigan	6 - Fixed Route Shuttle
	Cleveland Electric Co.	1

Vehicle	City or Operator	Number and Use (and Application)
Electrobus	None Yet in Service	
Rek Vee Club Car	Toronto, Ontario	34 (On order, 12 in use thus far)
	Oakville, Ontario	4
	Ottawa, Ontario	4
	Burlington, Ontario	2
	Cambridge, Ontario	6

None of the other Modified Motor Homes have as yet been placed in service.

APPENDIX B

VEHICLE SPECIFICATIONS

All information contained in the following tables was provided by the vehicle manufacturers or distributors. It is arranged in the order of vans and van conversions, small buses, and converted motor homes.

KEY

NA - Not available
NP - Not applicable
NR - Information not received

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN: ENGINE Gasoline	ENGINE Diesel	ENGINE Other	Transmission	Engine Location
Chevrolet Sportvan	Up to 12	Body on chassis	6 cylinder 250 cu. in. (350 cu. in. available)	NA	NA	3-speed manual or 4-speed manual (Automatic optional)	Front
Dodge Van and Maxivan	12 - 15	Body on 100, 200 or 300 series chassis	225 cu. in. 6 cylinder (or 318 cu. in. V8 or 360 cu. in V8)	NA	NA	3-speed manual (Automatic optional)	Front
Ford Club Wagon (Econoline)	Up to 12	Body on chassis	240 cu. in. 6 cylinder 300 cu. in. 6 cylinder (302 cu. in. V8 optional)	NA	NA	Automatic optional	Front

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
Chevrolet Sportvan	160 HP @ 3800 RPM	255 ft. lb. @ 2400 RPM	160/8300	Ratio: 4.10:1	Independent coil spring in front	201"	79.5"
Dodge Van and Maxi Van	NR	NR	NR	Front capacity 2700-3300 lbs. Rear capacity 2700-5500 lbs. Ratio 4.10:1	Independent front coil springs	176" to 212"	79.82"
Ford Club Wagon	6 cyl.-119 HP @ 3800 RPM.Man. 118 HP @ 4000 RPM. Automatic V8-155 HP @ 4000 RPM. Man. 158 HP @ 4200 RPM. Automatic	6 cylinder 187 ft. lbs. @2400 RPM. Automatic. 190'lbs. @ 2200 RPM.Mn. V8:249'lb @ 2400RPM. Man. 243'lbs. 2800 Rpm. Auto.	158/7800 (8 cylinder)	Front capacity 3600 lbs. Rear capacity 5050 lbs.	Coil springs	(Long wheel base dimensions) 187.1"	79.5"

Vehicle and Manufacturer	DIMENSIONS									
	Overall Height	Wheel Base	Front Overhang	Rear Overhang	Interior Height	Floor Height	Step Height	Step Risers	Clear-ance	Turning Radius
Chevrolet Sportvan	81.25"	125"	Total	of 76"	NR	NR	NR	NR	9.75" to 8.25"	NR
Dodge Van and Maxivan	79.13"	109" to 127"	NR	NR	47.18"	24.58"	NR	NR	NR	NR
Ford Club Wagon	77.9" empty 76.5" loaded	105.5" and 123.5"	NR	NR	48"	21.6"	16.7"	4.9"	6.3" min.	NR

Vehicle and Manufacturer	CURB WEIGHT			GROSS WEIGHT			MATERIALS AND CONSTRUCTION		
	Front	Rear	Total	Front	Rear	Total	Framing	Sides	Roof
Chevrolet Sportvan	2247 lbs.	1912 lbs.	4159 lbs.	NR	NR	6600 to 8300 lbs.	NR	NR	NR
Dodge Van and Maxivan	NR	NR	B300 series 4069 lbs.	NR	NR	B300 series 8200 lbs.	Steel	NR	NR
Ford Club Wagon	NR	NR	(Largest vehicle) 4540 lbs.	NR	NR	(Largest vehicle) 7800 lbs.	NR	NR	NR

Vehicle and Manufacturer	BRAKES					Wheels	Tires	Steering
	Operation	Front Size	Rear Size	Lining Area	Wt. to Lining Ratio			
Chevrolet Sportvan	Power assisted front disc and rear drum.	NR	NR	NR	NR	NR	Tubeless 8.00 x 16.5	Power steering option
Dodge Van and Maxivan	Power front disc brakes.	11.75 x 1.25	10 x 2.5	160 Sq. inches	160/ 4069 B300	8 stud disc	Tubeless car type or tubed truck type 8.75 x 16 10 ply	Power steering option
	Rear disc brakes.	12.82 x 1.19	12 x 2.5					
Ford Club Wagon	Power	12 x 3	12 x 2.5	NR	NR	NR	8.00 x 16.5 12 ply rear 10 ply front	Power steering option

Vehicle and Manufacturer	Door	Heating	Air Conditioning	Fuel Tank Capacity	Battery	Alternator	Special Options
Chevrolet Sportvan	Sliding side door (Vacuum door optional)	NR	A/C optional	36 gallon capacity	45 amp hr. (80 amp hr optional)	37 amps (42 amps or 61 amps option)	None
Dodge Van and Maxivan	Sliding door optional	Heater located in engine compartment. Optional auxiliary rear heater.	A/C optional Fresh air cooling	23 gallons	48 amp hr. (70 amp hr. option)	41 amps (50 or 60 amp options)	None
Ford Club Wagon	Sliding side door 41.3" wide	Fresh air heater	A/C optional	20.3 gallons	45 amp hour	42 amps	None

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
Chevrolet Sportvan	2-3 months	$4,000-4,500	
Dodge Van and Maxivan	3-4 months	$3850-6000	
Ford Club Wagon	3-4 months	$4240 minimum	

Table 1 ---- PAGE 7 of 7

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN: ENGINE Gasoline	Diesel	Other	Transmission	Engine Location
Conserv-A-Ride I Sheller Globe	10-13	(See Chevy Sportvan) Chevrolet G-30 van body reinforced and widened	350 cu. in. 4BBl V8	NA	NA	Automatic	Front
Fortivan by Coach and Equipment	10-16	Chevrolet CG 31305 GMCTG 31305 Dodge B300 Dodge Maxivan B300X Ford E345 conversions	300 cu. in. V8	NA	NA	3-speed manual	Front
Carpenter Cadet CV 1808 CV 2100 CV 2304	14-28 children or 12-22 adults	Body on Chevrolet Step Van chassis. (Used as example, alse available on Ford, GMC & Int'l Harv.)	Chevrolet 250 cu.in. 6 cylinder (350, V8 optional)	NA	NA	3 or 4 speed manual (automatic available)	Front

Table 2 ---- PAGE 1 of 7

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
Conserv-A-Ride I	160 HP @ 3800 RPM	255 ft. lb. @ 2400 RPM	160/7900	NA	Independent coil spring	201"	93"
Fortivan	Dependent on Chassis			Front 3300 lb. capacity Rear 5050 lb. capacity	Dependent on chassis		
Carpenter Cadet	100 HP @ 3600 RPM 120 HP @ 3600 RPM 245 HP @ 4000 RPM	175 ft. lb. @ 1800 RPM 215 ft. lb. @ 2000 RPM 365 ft. lb. @ 2800 RPM	245/14000	4.11:1 (4.56:1) (4.10:1)	Independent coil spring in front. Leaf spring in rear.	18'8" or 21' or 23'4"	84"

Vehicle and Manufacturer	DIMENSIONS									
	Overall Height	Wheel Base	Front Overhang	Rear Overhang	Interior Height	Floor Height	Step Height	Step Risers	Clear-ance	Turning Radius
Conserv-A-Ride I	94"	125"	NR	NR	61"	NR	NR	NR	NR	NR
Fortivan	----------Dependent on chassis----------						15.5"	10"		
Carpenter Cadet	125" or 133" or 157"	30" - 34"	61"-85"	78"	NR	NR	NR	NR	NR	NR

Vehicle and Manufacturer	CURB WEIGHT			GROSS WEIGHT			MATERIALS AND CONSTRUCTION		
	Front	Rear	Total	Front	Rear	Total	Framing	Sides	Roof
Conserv-A-Ride I	NR	NR	NR	NR	NR	7900 lbs.	NR	NR	Fiberglass and seven steel roof bows added to Chevrolet G-30 Van
Fortivan	----------			Dependent on chassis			----------		Steel Roof Cap
Carpenter Cadet	NR	NR	NR	NR	NR	6,000 to 14,000 lbs.	Flanged side parts	Zinc steel riveted	16 gauge steel riveted to bottom of roof bows

Vehicle and Manufacturer	BRAKES					Wheels	Tires	Steering
	Operation	Front Size	Rear Size	Lining Area	Wt. to Lining Ratio			
Conserv-A-Ride I	Power assisted front disc and rear drum	NR	NR	NR	NR	NR	8.75 x 16.50 8 ply	Power
Fortivan	Dual hydraulic	----------	----------	----------	Dependent	on chassis	----------	
Carpenter Cadet	Standard disc/drum Power option	NR-	NR	NR	NR	NR	G78-15B 8.75 x 16.5	Manual Power option

Vehicle and Manufacturer	Door	Heating	Air Conditioning	Fuel Tank Capacity	Battery	Alternator	Special Options
Conserv-A-Ride I		Fresh air heater (optional rear heater)	Optional A/C in front and rear	36 gallons	80 amp	61 amp	None
Fortivan	75" Behind front wheel Manual control	Rear heater 21000 BTU	available	30 gallons (50 gallon to become available)	NR	60 amp	Wheelchair lift available
Carpenter Cadet	Leaf opening 31" x 73.5" and rear emergency dr.	Forced air heating	available	30 gallons	45 61 or 80 available	37 amp 42 or 61 available	Lift available

Table 2 ---- PAGE 6 of 7

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
Conserv-A-Ride I	4-10 weeks	$8,500	
Fortivan	4 months	$10,000	
Carpenter Cadet	4 months	$8,000	

Table 2 ---- PAGE 7 of 7

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN:				Engine Location
			ENGINE			Transmission	
			Gasoline	Diesel	Other		
Flxible Flxette	19-23	Body on Ford M500 chassis	Ford 390 V-8	NA	NA	Ford 3-speed automatic	Front
Grumman	17-23	Body on either Chevy 3-100; Dodge RM 400 or Ford chassis	Chevrolet 454cu.in. V8 Dodge 440 cu.in. V8 Ford 390 cu. in. V8	NA	NA	Chevrolet AT475 Automatic or Dodge A727 Automatic	Front
Mercedes-Benz Model 0309D	13-19	Body on Mercedes chassis	NA	Mercedes 230 cu.in.	NA	Mercedes G20-5 5-speed manual (4-speed manual option)	Front
Minibus MBS Standard Transit Coach	18-23	Unitized body and frame	Chrysler Industrial 400 series V8 (300 option)	Detroit Allison model 453 (212 cu.in.)	Conversion to propane and natural gas available	Allison model AT540 4-speed automatic	Front

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
Flxette	255 HP @ 4400 RPM	376 ft.lbs @ 2600 RPM	255/11000	5.29:1 Options: 5.83:1 or 6.2:1	Leaf and beam	255"	90"
Grumman	NR	NR	NR	Front-5000 lb. capacity Rear 10,000 lb. capacity Ratio-4.56:1	Chevrolet springs Dodge torsion bar and springs	21'-24'	96"
Mercedes-Benz	94 gross HP @ 2800 RPM	188 ft. lbs @ 2400 RPM	94/10575	Front 3975 lb. capacity Rear 7275 lb. capacity Ratio 4.10:1	Leaf spring	236.2"	83.4"
Minibus	220 HP @ 4000 RPM	367 ft. lbs. @ 2400 RPM	220/14000	Front 5000 lb. capacity Rear 15000 lb. capacity Ratio 4.56:1 or 6.34:1	Front is leaf spring and torsion bar. Rear is air springs	23'9"	94"

Vehicle and Manufacturer	DIMENSIONS									
	Overall Height	Wheel Base	Front Overhang	Rear Overhang	Interior Height	Floor Height	Step Height	Step Risers	Clear-ance	Turning Radius
Flxette	105"	137"	35"	83"	75"	30"	14"	8.5"	14"	25 ft
Grumman	115"	159"	NR	NR	77"	NR	14"	NR	15" to 18"	NR
Mercedes-Benz	113"	137.8"	28.4"	70"	68" (74.8" without air conditioning)	29"	15.1" to 13.5" (loaded)	10" to 4.5"	NR	20'
Minibus	107"	159"	37.75"	88.25"	75.50"	29"	12.50"	8.25"	11"	29'6"

Vehicle and Manufacturer	CURB WEIGHT			GROSS WEIGHT			MATERIALS AND CONSTRUCTION		
	Front	Rear	Total	Front	Rear	Total	Framing	Sides	Roof
Flxette	NR	NR	NR	NR	NR	11000 lbs.	Welded steel	Riveted steel	Riveted steel
Grumman	NR	NR	8000 lbs.	5000 lbs.	9500 lbs.	14500 lbs.	.102" Aluminum alloy sheet	Riveted assembly	.051 aluminum T-shaped Roof bow
Mercedes-Benz	NR	NR	7640 lbs.	NR	NR	10575 lbs	Steel U-shaped rails and riveted tubular cross members	Welded steel	NR
Minibus	4400 lbs.	5200 lbs.	9600 lbs	5000 lbs	9000 lbs.	14000 lbs	Welded steel tubing	Riveted zinc steel	Fiberglass

Vehicle and Manufacturer	BRAKES					Wheels	Tires	Steering
	Operation	Front Size	Rear Size	Lining Area	Wt. to Lining Ratio			
Flxette	Vacuum power	14 x 2.5	15 x 4	380 sq"	11000/ 380	NR	7.00 x 18 8 ply (6)	Ford Power steering
Grumman	Power brakes Disc drum	14.2 x 1.5	15 x 4	NR	NR	16 x 6 Chev. 19.5 x 6 Dodge (6)	7.50 x 16 Chev. 8.00 x 19.5 Dodge	Chev., Dodge or Ford power steering
Mercedes-Benz	2 circuit hydraulic with air assistance	NR	NR	412 sq"	10575/ 412	Single front & dual rear 16" drum	6.50 x 16 Radial tube 10 ply	Power
Minibus	Hydraulic Disc	14 x 2.5	14 1/8 x 3	NR	NR	Steel disc wheel	8.00 x 9.5 (option of 7.50 x 17)	Power

Vehicle and Manufacturer	Door	Heating	Air Conditioning	Fuel Tank Capacity	Battery	Alternator	Special Options
Flxette	Pneumatic. 24" width. Behind wheel. (rear door option)	2 heaters 35000 BTU front 35000 BTU rear	A/C available	50 gallons	120 amp hrs	105 amps	Wheelchair lift available
Grumman	Right side behind wheel	2 heaters 40,000 BTU each	Available	Chevrolet 30 gallons Dodge 40 gallons	two 2-volt batteries	60 amps	Hydraulic wheelchair lift available
Mercedes-Benz	Behind front axle. Manually operated. 75.1"x31.8" (Driver's dr.70.8"x31.8"	1 water heater exchanger in front. 15000BTU 1 Diesel fuel powered hot air heater in rear 12000 BTU	A/C system 40000 BTU Rotary compressor	21 gallons	2 88 amp hrs (can accomadate two 100 amp)	Two 65 amp without a/c One 35 amp with a/c	Ramp and wheelchair lift available
Minibus	Air operated. 51" width. Front door behind wheel.	Main heater 65000 BTU	A/C optional 36000 BTU (option of thermoking 48000 BTU	NR	155 amp hrs	130 amps	Hydraulic lift and pump available

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
Flxette	60-90 days	$15000	
Grumman	2-3 months	$14-18,000	
Mercedes-Benz	4-6 months	$22-24000	
Minibus	4-6 months	$30-35,000	

Table 3 ---- PAGE 7 of 7

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN: ENGINE Gasoline	Diesel	Other	Transmission	Engine Location
Twin Coach TC-25	Up to 25	Unitized frame and body	Chrysler 413 cu. in.	Detroit Diesel Model 453N 212 cu.in. (option)	Propane and gas conversion	Allison 4-speed automatic	Rear
Electro bus Models 20 and 26	21-23	Unitized frame and body	NP	NP	DC series wound electric traction motor-special design with traction battery. Model 11A3 50 HP continuous rating.	No transmission. Motor connected directly to rear axle.	NP
Battronic EVC Van (Electric Work Vehicle)	10 or 15-25	Body on chassis	NP	NP	GE series wound DC traction motor 112 v. battery Maximum RPM 6000	Single speed. Helical gears. 1.96 to 1 ratio	Front
Airstream Argosy Compact Bus	15	Body on chassis	350 cu. in. V-8	NP	NP	Turbo hydramatic Model 400 with auxillary Hayden Air/Oil cooler	Front

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
Twin Coach	200 HP @ 3600 RPM Gas 130 HP @ 2800 RPM Diesel	360 ft.lbs. @ 2000 RPM (gas)	Gas: 200/14500 Diesel: 130/14500	Front 7000 lb. capacity Rear 15000 lb. capacity Ratio 5.29:1 gas 5.83:1 diesel ~~6.20:1 option~~	Air	302"	96"
Electrobus	NP	NP	NR	Front 7000 lb. capacity Rear 15000 lb. capacity	Leaf springs front and rear. Shock absorbers on front.	297" (model 20) 354" (model 26)	95"
Battronic	NP	NP	NR	Front 3800 lb. capacity Rear 7500 lb. capacity 10-passenger Front 4700 lb. capacity Rear 7800 lb. cap. ~~15-25 passenger~~	Leaf springs	188" (10 pass.) 229" (15-25 pass.)	83.25"
Airstream	NR	NR	NR	Front 4300 lb. capacity Rear 7500 lb. capacity 4.56:1 Rear axle ratio	Front spring capacity 2200 lbs Rear spring capacity 3700 lbs	240"	96"

Vehicle and Manufacturer	DIMENSIONS									
	Overall Height	Wheel Base	Front Overhang	Rear Overhang	Interior Height	Floor Height	Step Height	Step Risers	Clear-ance	Turning Radius
Twin Coach	112"	133"	71"	100"	75.5"	30"	14"	8"	12"	26'
Electrobus	101"	162" or 219"	88"	47"	77"	22"	14"	NR	NR	28' or 34'
Battronic	108" or 114"	111" or 153"	NR	NR	73" or 78"	NR	NR	NR	NR	NR
Airstream	107"	125"	NR	NR	79"	NR	15 1/2"	12"	NR	NR

Table 4 ---- PAGE 3 of 7

Vehicle and Manufacturer	CURB WEIGHT			GROSS WEIGHT			MATERIALS AND CONSTRUCTION		
	Front	Rear	Total	Front	Rear	Total	Framing	Sides	Roof
Twin Coach	3220 lbs.	7400 lbs.	10620 (gas) 11420 (diesel)	NR	NR	14500 lbs.	Welded steel	Riveted .063 aluminum	Riveted .050 aluminum
Electrobus	NR	NR	NR	NR	NR	NR	Welded construction. Square tube. Light wt. steel. Frame covered with aluminum skin.	All steel wall tube	All steel
Battronic	NR	NR	NR	NR	NR	NR	Pressed steel	Aluminum	Roof crowns .030 1 piece aluminum
Airstream	NR	NR	6820 lbs.	4300 lbs.	6200 lbs.	10500 lbs.	Extruded aluminum	Riveted .040 aluminum alloy sheet	Riveted .040 aluminum alloy sheet

Table 4 ---- PAGE 4 of __

Vehicle and Manufacturer	BRAKES					Wheels	Tires	Steering
	Operation	Front Size	Rear Size	Lining Area	Wt. to Lining Ratio			
Twin Coach	Air	15 x 4	15 x 6	628 sq."	14500/628	(6) disc type	8.00 x 22.5 8 ply	21"/6.5 turns
Electrobus	Power assisted hydraulic brakes with electric dynamic retarding	12.25 diam. 100° arc 5.5" lining	12.25 diam. 100° arc 7" lining	555 sq."	NR	NR	8.25 x 15 14 ply Steel belted radial	NR
Battronic	Electric dynamic braking optional on larger vehicle	12 x 2 -	12 x 3	104.72 front & 142.62 rear	NR	Split ring Stamped disc 8 stud	(4) 7.50 x 16 8 ply or 9.00 x 16 10 ply for larger vehicle	26.5 to 1 ratio 20" wheel
Airstream	Front-disc rotor Rear-drum	12.5 x 1.5	13 x 3.5	46 sq. in. front. 162.35 sq. in. rear	NR	16.5 x 6 rim	8.75 x 16.5	Integral hydraulic power, tilt steering wheel

Vehicle and Manufacturer	Door	Heating	Air Conditioning	Fuel Tank Capacity	Battery	Alternator	Special Options
Twin Coach	Air operated front Rear, optional 29" x 79" Front door in front of wheel	Two heaters: Total 110,000 BTU	A/C optional Thermoking B1-M6	50 gallons	180 amp hr.	120 amps	Extended step and hand rails. Wider door. Wheelchair ramp and lift.
Electrobus	Front and rear doors 29" wide	Driver 6500 BTU from traction battery. Fossil fuel heat burning gas for passengers. 40000 BTU 1/3 gallon fuel per 1 hr. heat	Air intake & A/C refrigeration equip. 50 A DC driver, driven by traction batteries.	NP	36 cell 72 volt 880 or 650 AH and 12 volt 160 AH auxilliary	NP	None
Battronic	10-pass. Rear doors 15-pass. Front door 54" wide 84.75"hydr.	Butane heater	NA	NP	Two 112 volt Variable capacity engineered to vehicle requirement. 12 volt DC accessory	NP	None
Airstream	Compressed air operated	35,000 BTU	40,000 BTU	30 gallons	2 batteries 80 amp hr.	50 amp idle, 80 amp at speed	None

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
Twin Coach	9 months.	$28-34,000	
Electrobus	Up to 6 months	$28,000 & $3000 per battery	
Battronic	——	$15,000 (10 pass.) $25,000 (15-25 pass) & $5000 per battery	
Airstream	6-8 weeks	$12,546	

Table 4 ---- PAGE 7 of 7

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN: ENGINE Gasoline	Diesel	Other	Transmission	Engine Location
APECO MRB Mid Range Bus	16-19	Body on Chrysler Motor Home chassis	Chrysler 360 cu.in. V8	NA	NA	Chrysler Model 727 3-speed automatic	Front
FMC Transit Coach	27	Body on FMC built Motor Home chassis	Chrysler I440-3	Detroit diesel 6V53 N40 V8 440 cu.in.	Propane Chrysler H440 V8	Chrysler Model A727, 3-speed automatic for gas & propane. Allison AT 450 4-speed automatic for diesel	Rear
Pace Arrow by Sheller Globe	15	Body on Pace Arrow Motor Home chassis	Dodge 318 cu.in. V8	NA	NA	Dodge 3-speed automatic	Front
Rek Vee Club Car	16-24	Body mounted on Chrysler RM 400 Motor Home chassis	Chrysler 440 cu.in.	NA	NA	Chrysler automatic	Rear

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
APECO MRB	245 HP	NR	NR	NR	NR	261.5"	95"
FMC Transit Coach	247 HP @ 3600 RPM Gas 209 HP @ 4000 RPM Propane 172 HP @ 2800 RPM Diesel	371 ft.lb. @ 2900 RPM Gas 313 Ft. lb. @ 2900 RPM Propane 385 ft. lb. @ 1500 RPM Diesel	247/18900 209/18900 172/18900	Ratio 1.00:1 1.41:1 1.45:1 2.45:1 2.20:1	Single transverse leaf spring in front. Independent trailing arms with torsion bar in rear.	360"	96"
Pace Arrow	NR	NR	NR	4500 lb. front capacity 6200 lb. rear capacity	Leaf springs in front. Torsion bars and springs in rear.	238"	94"
Rek Vee	NR	NR	NR	5000 lb. front capacity 10000 lb. rear capacity Ratio 4.56:1	Leaf springs	290"	96"

Table - ---- PAGE - of -

Vehicle and Manufacturer	DIMENSIONS									
	Overall Height	Wheel Base	Front Overhang	Rear Overhang	Interior Height	Floor Height	Step Height	Step Risers	Clear-ance	Turning Radius
APECO MRB	108"	145"	26.6"	90"	77 3/8"	28.5"	14"	NR	NR	26'
FMC Transit Coach	114"	162"	NR	NR	74"	31"	13"	12" x 27.5"	NR	28'
Pace Arrow	108"	125"	NR	NR	75"	NR	15.5"	NR	8"	30'
Rek Vee	112"	159"	NR	NR	78"	NR	12"	NR	NR	28'

Table 5 ---- PAGE 3 of 7

Vehicle and Manufacturer	CURB WEIGHT			GROSS WEIGHT			MATERIALS AND CONSTRUCTION		
	Front	Rear	Total	Front	Rear	Total	Framing	Sides	Roof
APECO MRB	---	---	6,900 lbs	---	---	10,000 lbs.	Steel tube	Steel tube walls. Aluminum outer skin.	Steel tube
FMC Transit Coach	3600 lbs.	9000 lbs.	12600 lbs.	6400 lbs.	12500 lbs.	18900 lbs.	Welded steel tube chassis	Welded aluminum channel and box section. Body 1 piece fiberglass.	Aluminum
Pace Arrow	2070 lbs.	1100 lbs.	7260 lbs.	4100 lbs.	6200 lbs.	11000 lbs	All steel cage frame Welded steel	NR	NR
Rek Vee	NR	NR	8000 lbs.	NR	NR	12000 lbs.	NR	Fiberglass skin	NR

Vehicle and Manufacturer	BRAKES					Wheels	Tires	Steering
	Operation	Front Size	Rear Size	Lining Area	Wt. to Lining Ratio			
APECO MRB	Dual hydraulic brakes. Rear drum. Front disc caliper type.	NR	12" x 3"	NR	NR	Single front dual rear 16.5" diam	8 ply D load rating 8.00 x 16.5	Power ratio 24 to 1
FMC Transit Coach	Disc dual caliper. 13" chain hydraulic.	NR	NR	NR	NR	NR	8 ply Michelin 7.50 x 17	Saginaw 708D20
Pace Arrow	Power front disc. 3.10" diameter.	---	12" x 3"	NR	NR	17.5"	6 1/2 ply 8.00 x 17.5	Dodge power steering
Rek Vee	Power front disc brakes.	NR	12 x 3	NR	NR	6 - 5 stud disc 19.5 x 6.0	8.00 x 17.5 8 ply Michelin	Dodge power steering

Table 5 ---- PAGE 5 of 7

Vehicle and Manufacturer	Door	Heating	Air Conditioning	Fuel Tank Capacity	Battery	Alternator	Special Options
APECO MRB	Passenger entrance behind wheel. 26" wide x 75" high. Driver: separate door.	Hotwater heat exchanger. Rear double blower 45000 BTU. Front single blower. 18000 BTU.	A/C standard 18,000 BTU rear, 14,000 BTU front	50 gallons	70 amps per hour	60 amps	Wheelchair lift being developed.
FMC Transit Coach	2 leaf opening inward. Pneumatic powered.	36000 BTU heater for driver. 110000 BTU heater for passengers.	A/C optional 50000 BTU	NR	NR	NR	Wheelchair lift being developed.
Pace Arrow	Behind wheel 26.5" width	Factory automotive heater and rear optional heater	A/C optional Thermoking . B1-M6	36 gallons. (27 gallon auxilliary tank)	70 amps plus auxilliary in rear of 70 amps	60 amps	Foldable ramp can be put in by user.
Rek Vee	Electric Worm drive 27" width	Front heater 40000 BTU. 2 rear heaters 40000 BTU	---	52 gallons	205 amp hrs.	105 amps	None

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
APECO MRB	8-10 weeks	$13000	
FMC Transit Coach	Up to six months	$35000	
Pace Arrow	4-5 weeks	$8495	
Rek Vee	4 months	$20-21000	

Table 5 ---- PAGE 7 of 7

Vehicle and Manufacturer	Seating Capacity	Type of Construction	POWER TRAIN: ENGINE Gasoline	Diesel	Other	Transmission	Engine Location
Winnebago	19	Body on Chrysler RM-350 Motor Home chassis	Chrysler 440-3 V8	NA	NA	3-speed automatic (5-speed option)	Front
Conserv-A-Ride II Sheller Globe Models 2000 or 2200	11 or 16	Dodge RM 300 300 chassis or 350 chassis (see Dodge)	Dodge 318 cu. in. (Option of Dodge 440 cu. in.	NA	NA	Automatic	Front

Vehicle and Manufacturer	ENGINE CHARACTERISTICS			Axle	Suspension	DIMENSIONS:	
	Power	Torque	Power To Weight Ratio			Overall Length	Overall Width
Winnebago	NR	NR	NR	5000 lb. front capacity. 7500 lb. rear capacity. Ratio 4.56:1	Springs and torsion bars	267"	87"
Conserv-A-Ride II	NR	NR	NR	NR	NR	NR	NR

Table 6 ---- PAGE 2 of 7

Vehicle and Manufacturer	Estimated Delivery Delay	Base Price	
Winnebago	2 months	$12000	
Conserv-A-Ride II	8-10 weeks	$12,800	

APPENDIX C

REPORT OF INVENTIONS

A diligent review of the work performed under this contract has revealed no new innovation, discovery, improvement or invention.