Chapter 2: The Status and Potential of Automated Guideway Transit in Urban Areas

THE CURRENT STATUS OF URBAN PASSENGER TRANSPORTATION

Urban transportation service and the location of urban activities are intimately related. Changing locations of people and jobs in urban areas, particularly in recent decades, has had significant effects on the supply and mix of urban transport services. Population within Standard Metropolitan Statistical Areas (SMSA) increased nearly 17 percent between 1960 and 1970, yet only 0.1 percent of the increase occurred within the central cities of those SMSAs. Urbanized areas outside of central cities, the suburbs, experienced a 33.1 percent increase in population in that decade.

One result of these population trends is a greater homogeneity of population density throughout a metropolitan area, with a concomitant greater dispersal in the location of economic activities, over ever larger urbanized areas.

Job locations have migrated outward from the central cities as well, causing a substantial loss in numbers of central city jobs in recent years. In SMSAs with a population over 250,000, for example, there were 41 million jobs in 1970, but only 23 million of these were in the central cities of those metropolitan areas. The rest were located in surrounding suburbs.

Such diffusion trends have had major impacts on the daily journey to work in metropolitan areas. Considering only SMSAs of a million or more population, the number of daily work trips with both origin and destination in the central city declined by 1.2 million between 1960 and 1970. Work trips into the central city from surrounding areas increased by nearly a million, as did the "reverse commute" work trip from the central city to the suburban ring. Work trips with both origins and destinations in the suburbs, however, trips which avoided the central city entirely, increased most of all, by 3.6 million daily trips. Thus, not only has total trip-making increased significantly in United States metropolitan areas, the origins and destinations have spread diffusely over a larger land area within larger metropolitan areas.

Diffuse trip patterns represent precisely the kinds of urban travel demand most difficult to serve effectively with conventional public transit systems. Transit service shortcomings, together with the trends toward more separated locations of economic activity and diffuse travel behavior, have together tended to reinforce, in the aggregate, dependence on the private automobile for the great majority of urban trips, even work trips. Yet the private automobile, too, has critical deficiencies in meeting demand for urban travel.

THE AUTOMOBILE

Use of the automobile has contributed to the changes in urban form already described. It has allowed the diffusion of each type of activity to continue throughout the urban area. Traditional central business district functions have become more diffusd and, in some cases, have been replaced by suburban shopping and business centers.

The private automobile has encouraged an urban structure which favors individualized or small group transportation. Unfortunately, as more and more families have found it necessary to own one or more automobiles, the disadvantages of dependency on automobile transportation have increased. These disadvantages include increased traffic congestion, greater amounts of valuable urban space required for movement and parking, air pollution (50 percent or more of total air pollution is attibuted to the automobile), and high energy consumption (about 50 percent of the nation's petroleum is consumed by the automobile). The problems of the young, old, physically handicapped and other disadvantaged persons who cannot drive or do not own an automobile have also become increasingly apparent.

PUBLIC TRANSPORTATION

In comparison with the automobile, public transportation has not provided an attractive alternative. The transit industry reports a steady decline in transit patronage over the past 30 years, despite a rapid increase in total urban travel demand. (See Figure 1 below.) Because trip origins and destinations are increasingly scattered

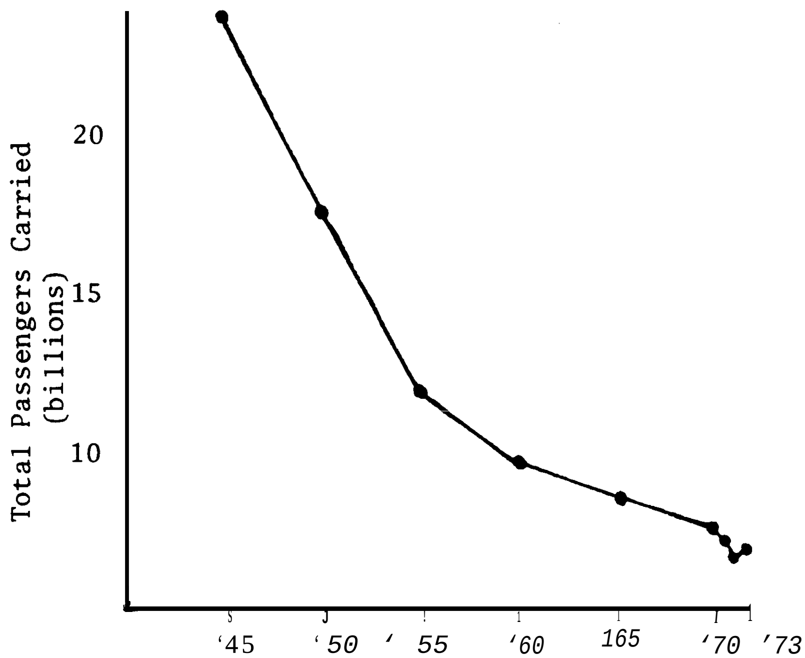


Figure I.—Transit Patronage Trends 1945-1973

Source: 1978-74 Tran81t Fact Book—American public Transit Association.

throughout the urban area, the attractiveness of fixed route multi-passenger public transportation is not likely to increase. Scattering of origins and destinations militates against large vehicle mass transportation service on fixed routes. This inadequacy in serving diverse origin and destinations is particularly apparent in off-peak hours.

Rail rapid transit systems provide the highest capacities and are useful in high-density corridors linking common origins and destinations. They are also the least flexible in their coverage. Besides high capacity, rapid rail systems have other indirect advantages over automobiles: less pollution, lower petroleum fuel consumption per passenger, and less diversion of land to transportation-related use. Unfortunately, the number of metropolitan areas with sufficient concentration of trip origins and destinations is limited. The high capital cost for new rapid rail systems now under construction, or being planned, indicates that their direct cost per passenger may be higher than the comparable costs of highway construction. Thus, rail rapid transit systems are a limited alternative to automobiles.

Buses operating on exclusive or reserved rights-of-way have been successful. Bus riding is not considered an attractive alternative to automobiles when sharing highways with other traffic. They suffer from auto-induced traffic congestion, loading and unloading delays, route inflexibility, infrequency of service, and slow speed. Even total trip times on express buses tend to be longer than for automobiles.

Two other urban transportation services in general use—taxicabs and demand-responsive, Dial-a-Ride systems—have limitations other than the quality of service they provide. Taxicabs are expensive for single riders. Also, institutional problems and regulations protecting other interests prevent altering taxi service to meet public transportation needs in most cities. Dial-a-Ride systems provide service of a quality somewhere between scheduled buses and taxicabs, but initial experimenting with such programs indicates they require large public subsidies to attract and keep riders.

Alternative Approaches To Meeting Urban Transportation Needs

In the previous section, it has been indicated that the transportation needs of urban communities are not being met in a satisfactory manner by private automobiles or by existing public transportation modes. This has prompted a search for new approaches into two directions. The first is reducing or redistributing the urban transportation demand. The second is trying to meet current and projected levels of urban transportation needs with new forms of transportation.

Approaches to reducing or redistributing urban transportation demand include:

- Changes in land use patterns so that employment and activity centers are located near residences so as to reduce travel.
- Staggered work hours to reduce peak hour demands on existing transport facilities.
- Clustering of activities, such as shopping, recreation, living and education, to encourage walking and to provide ready access to public transit.
- Creative use of transport facilities to guide urban development, including the acquisition of contiguous real property to integrate the design and development of stations and surrounding neighborhoods.
- Parking restrictions and toll charges which discourage auto loadings of one person per vehicle and the unnecessary use of large family-sized automobiles with their excessive need for space.

This list is not exhaustive. However, it does suggest the kind of changes that could reduce or redistribute the demand for transportation. In addition to what can be done to reduce or redistribute transportation demand, technology may be used to produce innovative solutions to transportation problems. While there are a variety of approaches, one approach which has received considerable attention in recent years is the use of small vehicle fixed guideway systems which require no human operator, that is AGT. Such systems could be used alone or combined with conventional line-haul modes such as rapid rail or fixed route buses.

Impetus for development of AGT systems in the United States was provided in 1966 by the Reuss-Tydings Amendments to the Urban Mass Transportation Act of 1964. These amendments required the Secretary of Housing and Urban Development to:

> ". . . undertake a project to study and prepare a program of research, development, and demonstration of new systems of urban transportation that will carry people and goods within metropolitan areas speedily, safely, without polluting the air, and in a manner that will contribute to sound city planning. The program shall (1) concern itself with all aspects of new systems of urban transportation for metropolitan areas of various sizes, including technological, financial, economic, governmental, and social aspects; (2) take into account the most advanced available technologies and materials; and (3) provide national leadership to efforts of States, localities, private industry, universities, and foundations."

Since passage of the Reuss-Tydings Amendments, many studies have been undertaken of the potential for AGT systems, in meeting transportation needs and a number of research, development and demonstration programs.

Although this assessment is concerned with a particular approach to urban transportation problems, it should be noted that there is probably no single solution. Some combination of approaches involving ways to reduce demand and utilization of new technology will probably be necessary.

Characteristics and Current Applications of AGT Systems

Automated guideway transit systems have two distinguishing features:

- Vehicles are *automated*, that is, they can carry passengers without an operator on board.
- They have their own roadways, which are usually called *exclusive guideways*. These may be on elevated structures, at ground level, or underground.

AGT systems vary greatly. Any classification scheme is somewhat arbitrary, but three categories have been defined in the course of this study:

Shuttle-Loop Transit (SLT).
Group Rapid Transit (GRT).
Personal Rapid Transit (PRT).

The three categories differ in degree of technical sophistication, service attributes, vehicle operations, and readiness for use. These differences are summarized in the accompanying table.

Characteristics of AGT Systems

	SLT	GRT	PRT
Technical sophistication	Simple. Needs some refinement.	Intermediate, Problems in application.	Complex. Partially demonstrated.
Service attributes	En route delays and transfers are necessary.	Waiting time for proper vehicle. In group travel, transfers may be necessary.	Travel alone or with people by choice. Minimum en route delays, no transfers.
Vehicle operations	Vehicles follow unvarying paths.	Vehicles follow multiple paths. Switches required.	Vehicle follows path tailored to needs of traveler.
Readiness	Available. Many systems in specialized service, none in urban centers.	Emerging. 1 revenue system exists and 1 is in construction.	Conceptual. No system in use or construction. Testing abroad.

SLT SYSTEMS

(Characteristics.—Shuttle-loo transit systems have **a** single essential characteristic. The vehicles folow unvarying paths and make little or no use of switches. Vehicles may be of any size and may be used alone or coupled together in trains. Headways are 60 seconds or more. Capacities vary depending on vehicle size. Speeds range from 8 to 30 { .

In a shuttle system, the vehicles move back and forth on a simple guidewa , without front or rear orientation. Shuttles have stations at oth en s of the run and may also have intermediate stations.

In a Zoo system, the veh]cles move continuously around a closed path which may contain any number of stations. Stations are on the main line. Possible variations of SLT include double guideway lines with switches at the end and single guideway lines with multiple **cars** and a by-pass near the midpoint of the line.

Combinations of shuttles and loops can be constructed.

U.S. SLT Application.—In the U. S., 15 SLT systems have been built or are under construction. Nine are in service.

The nine systems in revenue operation are at:

1. Tampa International Airort, Florida.
2. Houston Intercontinental Airport, Texas.
3. Seattle-Tacoma International Airport, Washington.
4. Love Field, Dallas, Texas (inactive at present).
5. California Exposition and State Fair, Sacramento.
6. Hershey Amusement Park, Hershey, Pennsylvania.
7. Magic Mountain, Valencia, California.
8. Carowinds, Charlotte, North Carolina.
9. Kings Island, Kin s Mill, Ohio.

Six SLT s ystems now under construction are at:

10. Kings Dominion, Ashland, Virgnia.
11. Pearl Ridge, Honolulu, Hawaii.
12. Bradley Field, Hartford, Connecticut.
13. Fairlane Town Center, Dearborn, Michigan.
14. Miami International Airport, Florida.
15. Busch Gardens, Williamsburg, Virginia.

Characteristics of these systems vary greatly. Examples of a shuttle, **a** 100 , and a shuttle-loop combination are briefly described to illustrate the characteristics. For additional information, see the Panel Report on Current Developments in the United States.

An example of a shuttle system is the SLT at the Tampa Airport where there are two shuttles on parallel guideways connectm each of four satellite or “Air-side” terminal buildings with the h Main or “Land-side” terminal. The longest run is 1,000 feet. Vehicle capacity is 100 passengers. The maximum speed is 30-35 mph. The capacity is 5,000 passenger per hour in each direction—the same capacity as two freeway lanes for automobile traffic.

A loop s stem has been installed at the Houston Intercontinental Airport. This eight-station system has 6,200 feet of guideway. At resent, up to six trains, each three cars lon , can run with an average headway of three minutes. Maximum speed is 8 mph with a capaclty of 720 passengers hour in each direction. The fleet can be enlarged to 18 trains. At headways of 60 seconds, capacity will reach 2,160 passengers per hour in each direction.

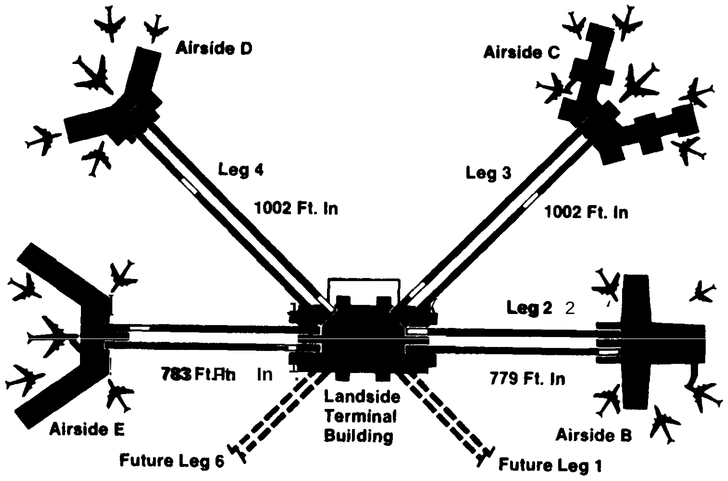


**Figure 2.—Passenger Shuttle System Layout
Tampa Airport**

The Seattle-Tacoma Air ort has a shuttle-loop combination. Referred to as the Satellite Transit System, it includes two loops and a shuttle which provide transportation between the main terminal

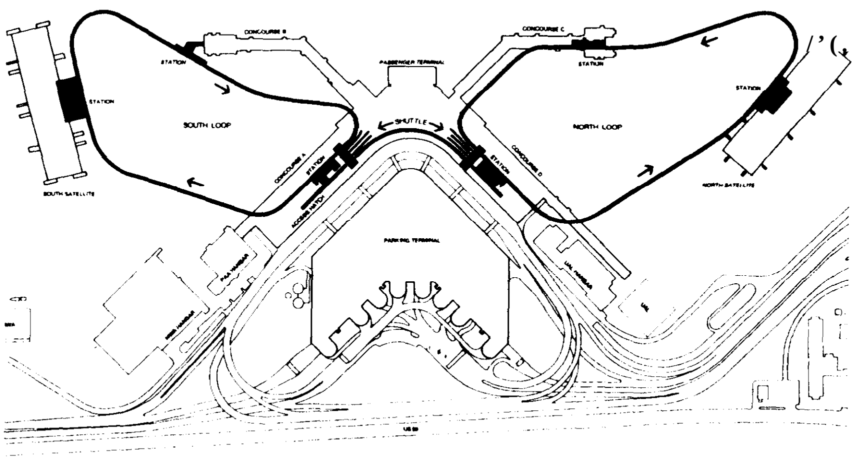


**Figure 3.-Satellite Transit System Layout (Note: two loops and a shuttle.)
Seattle-Tacoma International AirporL**

and two satellites. Nine vehicles are in service and three more are on order. Maximum loop capacities are 14,400 passengers per hour. Maximum speed is 27 mph.

Foreign SLT Application~.—There are only two AGT installations in actual revenue service outside the United States. Both are SLT s stems. One is a simpIe loop system which has been built at the Y atsu Amusement Park in Chiba Prefecture near Tokyo, Jap an. Two 30 passenger VONA vehicles operate on a 1300-foot track at two minute headways. The other installation is the VEC system which connects a department store in Paris with a remote parking garage about 1,000 feet distant.

Potential SLT Applications.—To date, SLT systems have been installed to accomplish three kinds of specific trip purposes: travel between two major activity centers, travel within a single defined activity center such as a park or recreation area, or travel from parking areas to a specified destination such as an air terminal. There are a number of additional applications for SLT which could be tested. These would provide data on the utility of the systems outside the rather specialized and/or novelty situations in which they have been used. Thus, SLT systems may have high potential for use in conjunction with conventional rail rapid transit as a collector or distributor at stations located near major activity centers, Another potential application is the use of elevated SLT systems to provide circulation in central business districts and other places where surface congestion impedes movement.

GRT SYSTEMS

Characteristtis.—Group rapid transit systems are designed with branching routes and serve groups traveling with similar origins and destinations. GRT vehicles may e of various sizes, thou h 10 to 50 passenger vehicles are likely to be most common. Vehicl es may be coupled together in trains.

GRT systems are likely to have stations located off the main line, allowing vehicles to pass a station while other vehicles are stopped there.

Switching capability allows the GRT s stem to provide service on a variety of routes much like bus service,but without the delays from traffic congestion. The traveler using a GRT system, must be careful to board the correct car. Also, GRT passengers making relatively long trips in metropolitan-scale systems may find it necessary to make one or more transfers. Thus, there may be significant waiting time involved.

GRT systems maybe designed too crate at headway s ranging from 60 seconds. to as low as three seconds or very advance versions. Since line capaclty is a direct function of vehicle capacity and headway, a GRT line with average headways of 30 seconds and average vehicle loads of 20 people would carry 2,400 people per direction—about the same as a freeway lane. Line capacity can be readily increased by coupling vehicles together into trains or reducing headways. However the system complexity increases significant as headways are reduced.

U.S. GRT Applications.-Because GRT is more complex, fewer systems have been built than SLT systems. Of the two United States systems, one is AIRTRANS which is located at Dallas/Ft. Worth Airport and the other is the system at Morgantown, West Virginia. Only AIRTRANS is operational. AIRTRANS includes 13 miles of guideway linking 55 stations. There are 51 passenger vehicles and 17 utility vehicles. Maximum speed is 17 mph. The guideway network permits 17 different service routes with a system capacity (over all routes combined) of **9,000** passengers, 6,000 pieces of luggage and 70,000 pounds of mail per hour. (No single part of the system would carry this total.)

Foreign GRT Applications.—No GRT systems are operational in other countries. *i* owever, three systems are under construction in Japan and one in Canada.

AIRTRANS SYSTEM AT THE DALLAS/FT. WORTH AIRPORT

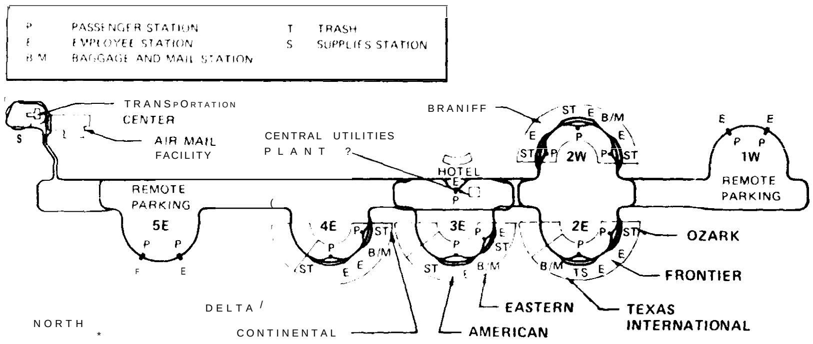
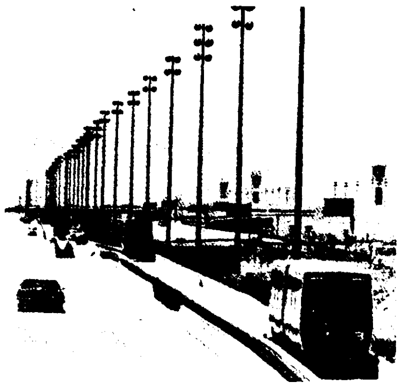
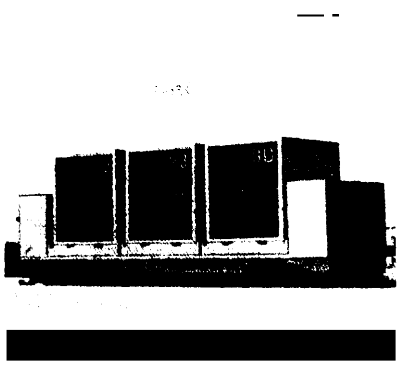


Figure 4.—Schematjc System Layout



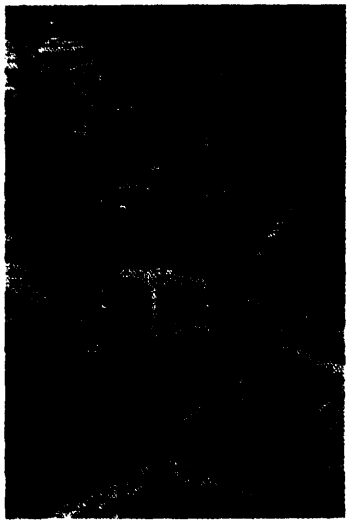


Some of the 51 Passenger Vehicles

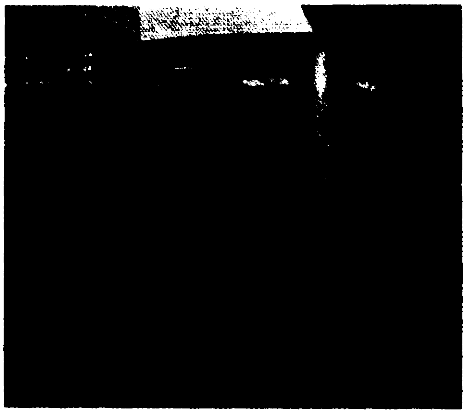
One of **the 17 Utility Vehicles**

Potential (GRT .4pplicatiow.-GRT systems could provide a broad range of services in major activity centers such as central business districts. These services include a variety of schedules for peak period use and on-demand service a times of low activity. With automatic coupling of vehicles, a technique which is currently being perfected, vary-ing route densities can be accommodated by selective coupling of vehicles as they converge onto heavily traveled corridors from outlying areas. This technique would permit a downtown loop to be fed by several radials connecting the CBD to suburban areas. As vehicles enter the central loop they could be automatic coupled together into two- to four-car trains, depending on the volume of traffic. When :eady to depart the downtown area, the: could be uncoupled, pref-erable- in a station, to help passengers board the correct vehicle for the outbound trip.

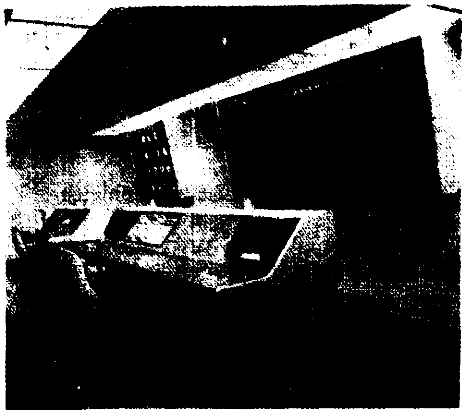
An important consideration is the potential of GRT to evolve in both capacity and versatility. A relatively simple sytem, or segment system, could be installed and later expanded. With proper planning, off-line stations could be added and headways reduce , without major alterations to the basic guideway network.



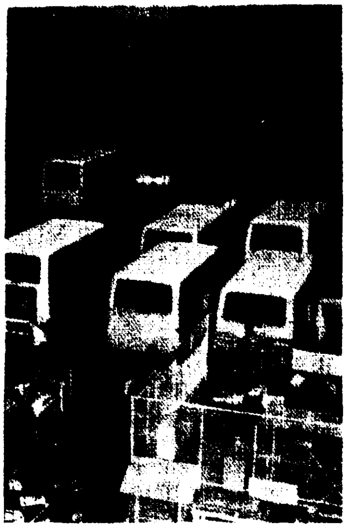
Vehicle Operating in Downtown Morgantown



Vehicle at Engineering Station



Central Control Console



Assembly of Vehicles at Boeing Aerospace Company Plant

PRT SYSTEMS

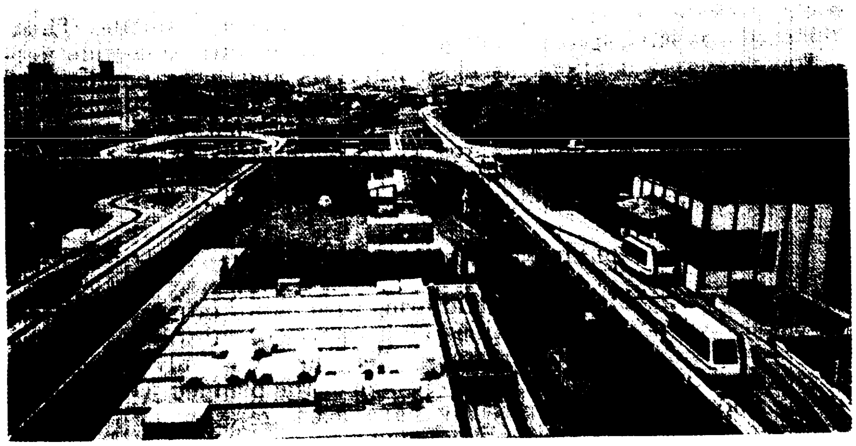
Characteristics.-The basic features of the personal rapid transit concept are small vehicles (up to six passengers) designed to carry one person, or a small group of people traveling together, non-stop from origin to destination over an extensive network of guideways connecting many stations. To provide convenient access ?or a maximum number of people, guideway grids have been proposed with spacings close enough to limit walking distances to mile or less.

The salient feature of PR&is provision of maximum convenience and flexibility. The result would be a level of service that is truly competitive with the private automobile. Thus, vehicles would move to any location throughout an extensive guideway network without enroute delays or transfers. Strangers could elect to ride together in a PRT vehicle if the happened to get on at the same time and were going to the same estimation.

Because of the lower vehicle capacity in PRT s stems, achieving the same line ca acities possible mth the less combex GRT systems requires that PhT vehicles operate at very short headways. For example, to move 2,500 people per hour at the average occupancy level of the private auto (1.4 people per vehicle) would require 1,800 vehicles per hour, or one every two seconds. Intersections would be equipped with switches enabling vehicles to make turns or continue in the original direction of travel much like automobiles at street intersections.

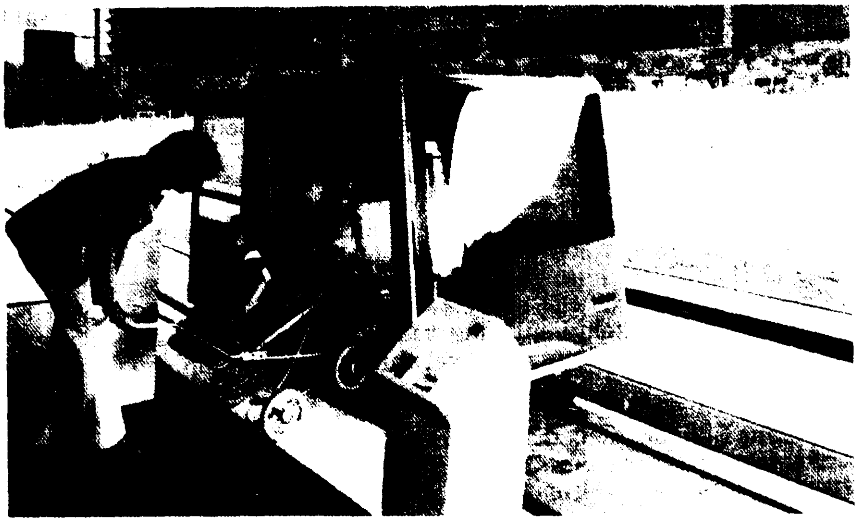
United States Preapplications.—There are no PRT developments or planned applications in the United States.

Foreign PFT Applications.—Prototype systems have been constructed in Japan, Germany and France. The Japanese CVS system is installed near Tokyo and includes a 4.8 km. test track, a sophisticated control system and 60 vehicles. These have operated at headways of six seconds and speeds of 30–40 km/h. A key objective of the test program is achieving safe operation at one-second headways..



CVS Project Experimental Center, Higashimurayama Tokyo, Japan

The German system, Cabinentaxi, includes five, three-passenger vehicles operating on a 1136 meter test track. Headways of .5 second have been achieved in the laboratory, and passenger carrying demonstrations under manual supervision have been conducted at one-second headways. The ARAMIS system in France which merges individual vehicles into groups has been tested on a one-km. test track with three vehicles operating at headways of 0.2 seconds between Yehicles and 60 seconds between grou s. This test track is no longer m existence, but a new one will be buiYt soon.



Cabinentaxi—Hagen, West Germany

Potential PRT Applicatioms.—The PRT concept was stimulated partly b," the desire to develop a public transportation s~"stcm which would provide an attractive alternative to the automobile. Thus, application is envisaged in well populated areas with area-wide networks, numerous stations at close intervals and large numbers of vehicles. The Aerospace Corporation estimates that some 10,000 square miles of urban area in the United States may be approriate for PRT service. Serving this area would require 30,000 miles of one-way guideway and three million PRT vehicles. In this same area, PRT would compete with other transportation systems,

AGT Installations Studied in the United States

A survey of public agencies and firms with major interest in installations of AGT systems identified 36 instances of substantial studies completed for future AGT systems. The survey is only suggestive and Is not intended to be complete. Some of the planned AGT' installations may be, or may recently have been, rejected or deferred. However, because of the sizeable planning work and expense involved in each case, they are included to indicate the level of interest and activity in AGT development.

These planned systems have not been grouped by system class (SLT, GRT or PRT) because more than one class has been proposed for some locations. (For example, all three types of AGT technology have been studied for potential application m Minneapolis.) Instead, this listing is organized by the type of location for which the system has been proposed.

METROPOLITAN NETWORKS AND CORRIDORS (6)

Denver Region, Colorado.
Twin Cities Area, Minnesota.
San Diego Region, California.
Santa Clara County, California.
Pittsburgh, Pennsylvania.
El Paso, Texas—Juarez, Chi., Mexico.

AIRPORTS (9)

Atlanta, Georgia.
Boston, Massachusetts.
Chicago, Illinois (O'Hare).
Detro]t, Michigan (Metropolitan).
Los Angeles, California (International).
Oakland, California.
San Francisco, California.
New York, New York (J. F. Kennedy).
Newark, New Jersey (International).

CBD/CENTRAL CITY (9)

Ann Arbor, Michigan.
Detroit, Michigan.
Las Vegas, Nevada.
Long Beach, California.
Minneapolis, Minnesota.
Mid Manhattan, New York, New York.
Lower hlanhattan, New York, New York.
Norfolk, Virginia.
San Diego, California.

MULTIPLE PURPOSE DEVELOPMENTS (8)

Crown City, Kansas.
Echelon, New Jersey.
Cameron, Alexandria, Virginia.
Plaza del Ore, Houston, Texas.
Post Oak, Houston, Texas.
Southfield, Michi an.
Interama, Dade8ounty, Florida.
Crystal City, Arlington, Virginia.

31 EDIC!,4 I, CENTERS (4)

Detroit Medical Center Corp., Detroit, Nlichigan.
Duke Universit~' Medical Center, Durham, North Carolina.
The Universit Health Center of Pittsburgh, Pittsburgh, Pa.
Texas MedicdCenter Inc., Houston, Texas.

As can be seen from the above, planning studies ,of AGT cover a variety of applications. The proposed plans for medical centers, provision of transportation in central city areas, and provision of metropolitan network and corridor transportation are new applications.

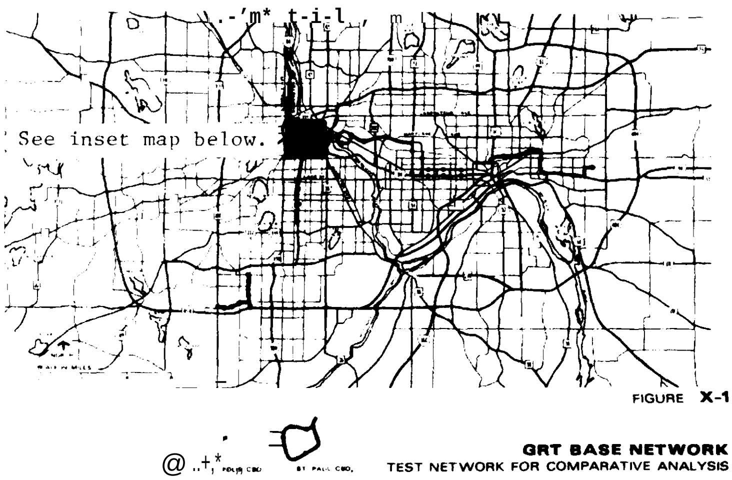
Some of the plans under evaluation are ambitious. For examplet there are four studies in metropolitan areas involving SLT or G T networks. A total of about 380 miles of dual guideways and almost the same number of stati~ns are being considered. T[ese would be built in stages at a total estimated cost of $6.7 billion. For comparison, there are now about 500 miles of rail rapid transit routes in the United States and the Washington METRO system will add about 100 miles at a cost of about $4.5 million.

To illustrate some of the reposed applications, a system plan under consideration in each o the three AGT classes is summarized below.

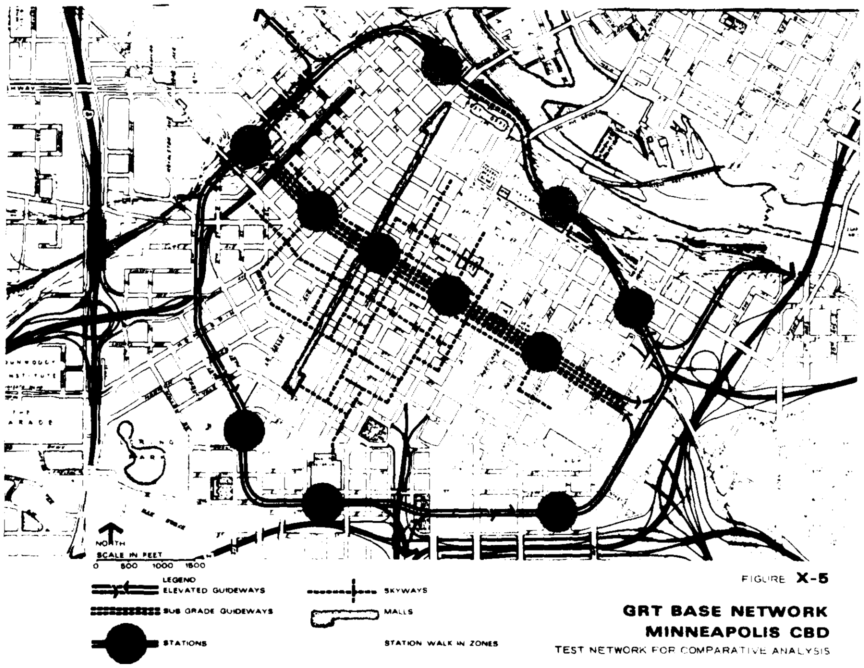
SLT

A "people mover" system to serve the C oastal City complex in Arlington, Va. is the subject of a current U TA-fianced technical study. A simple loop system with several on-line stations has been ro osed to provide convenient transportation to and from the E i $TRO station (under construction), to facilitate access to remote parking and for internal circulation within this office-cornmercial-residential development.

PROPOSED MINNEAPOLIS-ST. PAUL GRT SYSTEM



Metropolitan Area Network (Dots indicate station location.)



Details of Network for Downtown Minneapolis

Source: ***Automated 8mall Vehfcle Fiaed (Wdeway 8@em8 8tudg*, Technical Re ort IWO. 75-03, by De Leuw, Cather, Co., Inc., Bather, Ringnose, Wolsfeld, Inc., Honeywe I, Inc. ; hfarcb, 1975.**

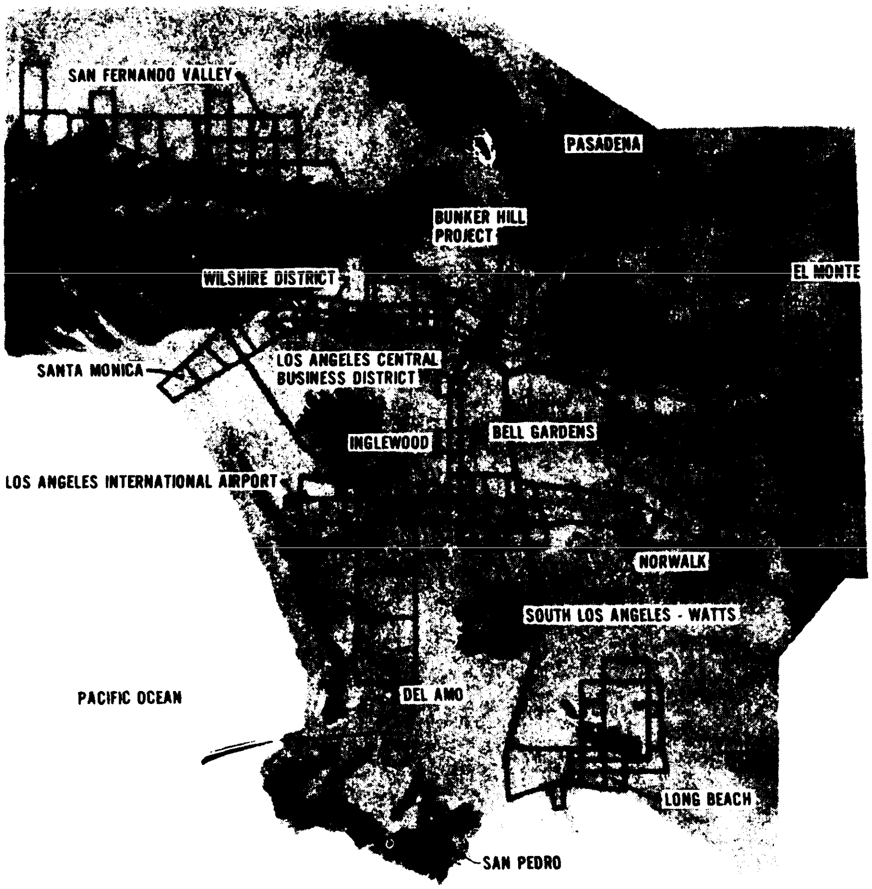
GRT

The Twin Cities Area Metropolitan Transit Commission, based upon detailed studies by a team of consultants led by Do Leuw Cather and Company, Inc. has determined that a GRT system would provide a satisfactory solution to transportation needs in the Minnea polis-St. Paul region. One plan which has been recommended proposes Euilding circulation systems in the two metro centers. Later extensions would provide lines into fully developed suburbs as indicated by the map on the preceding page.

A final decision on the system to be built awaits further detailed engineering studies in which GRT concepts will be compared with alternatives such as light rail.

PRT

The Aerospace Corporation, one of the strongest advocates of the PRT concept in the United States, in a study of the Los Angeles area, reposed *638* one-way miles of guideway, 1084 stations and 64,000 vehic res, as shown below.



Proposed PRT Grid for Los **Angeles**

The Aerosp ace Corporation compared its proposal to a conventional rail and excl usive busway system recommended by another group to the Southern Califorma Rapid Transit District, That system is reported to include 116 miles of rail, 24 miles of elevated busways and 62 stations. The Aerospace Corporation contends the PRT system could be built at about half the cost and provide better service.

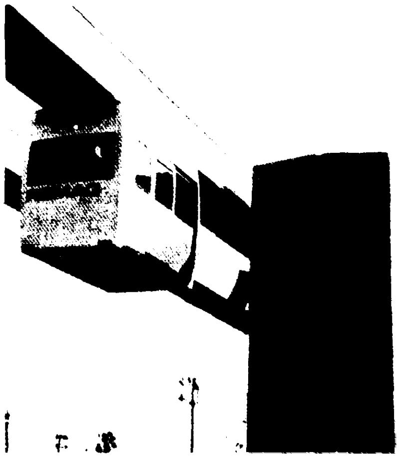
Further descriptive information about some of the applications proposed are contained in the Report of the Panel on Current Developments in the United States.

Suppliers of AGT Systems

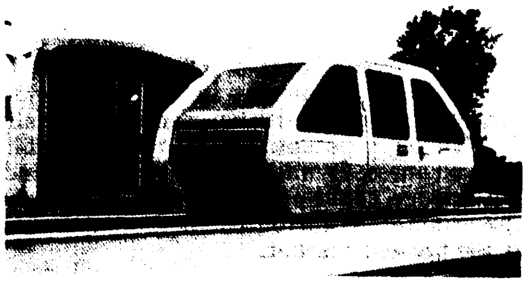
The number of existing systems and even greater number of plans for new ones indicates the high level of interest which AGT development has generated. Six different firms have installed the existing systems. Nine others have invested their own resources in develop-

SELECTED VEHICLE SYSTEMS WHICH HAVE FOUND NO MARKET
(Post-Transpo 72)

Astroglide
PRT Systems Corporation



R.omag
Monocab, Inc.
Rohr Industries



Palomino
Aerial Transit
Pullman, Inc.

ment efforts but have not received a contract for a revenue installation. Clearly, many firms have believed in a market potential for AGT.

The 17 AGT systems now in existence in the United States have been supplied by six firms who remain in the business and one group formed for a single reject, Braniff International's Jet-rail system for Love Field, Dallas, Texas. The firms are:

	Number of installations
• Westinghouse Electric Corporation, Pittsburgh, Pa_. -----------	4
Universal Mobility , Inc. Salt Lake City, Utah ---------------- --	6
• Rohr Industries, (Monotrain) Chula Vista, Calif - -----------	2
. Ford Motor Company, Dearborn, .Mich - -------------------- ---	2
. LTV Aerospace Corporation, Dallas, Tex- -------------------- --	1
. Boeing Aerospace Company, Seattle, Wash- --------------------	1

Firms which have spent considerable time, effort and money on the development of full-scale test tracks and vehicles, prototype systems or temporary demonstration projects, such as Trans o 72, but have not yet sold a revenue passenger system in the United States include:

- Otis Elevator Company, Inc., Transportation Technology Division, Denver, Colorado.
- Rohr Industries, Inc. (Monocab), Chula Vista, California.
- General Motors Corporation, Transportation Systems Division, Warren, Michigan.
- pRT Sys,ems Corporation (associated with Braniff), Chicago, Illinois.
- Mobilit~ Systems and Equipment Company, Los Angeles, California.
- Alden Self-Transit Systems Corporation, Bedford, Massachusetts.
- Bendix Corporation (Dashaveyor), Ann Arbor, Michigan.
- Pullman, Inc. (Aerial Transit), Las Vegas, Nevada.
- Uniflo Systems Company, Minneapolis, Minnesota.

It is estimated that privately financed AGT development costs incurred by the 15 companies listed above total about $100 million. Lack of sales and unfavorable market conditions have caused some firms to curtail their programs or withdraw entirely. Others are considering abandonin their AGT programs. Certainly the number of suppliers exceeds % current market. One reason is that UMTA actively promoted AGT development in the late 1960's and early 1970's. Firms without prior transit experience, especially aerospace fires, perceived AGT as a potential new market to fill the gap of declining aerospace business. It was hoped by UMTA and these firms that aerospace knowledge could enable significant advances in AGT development. These factors contributed to the large number of suppliers relative to the present market.