Chapter 1: Summary

This report is a technology assessment of Automated Guideway Transit s stems, undertaken b The Office of Technology Assessment at t{ e request of the U.S. Senate Committee on Appropriations, Transportation Subcommittee. Detailed findings are presented in Chapters 2 through 5. Major findings and conclusions are summarized in this chapter, which is organized as follows. The first section contains definitions and brief descriptions of Automated Guideway Transit systems. The definitions are followed by a summary of the major technical, economic, social, and institutional issues associated with Automated Guideway Transit. Next is a review of current R & D programs, with emphasis on those sponsored by the Urban Mass Transportation Administration (UMTA). 1n the last section, four options are outlined for research and development activities by UMTA in the coming fiscal year.

DEFINITIONS

Automated Guideway Transit (AGT) is a class of transportation systems in which unmanned vehicles are operated on fixed guideways along an exclusive right of way. The capacity of the vehicles ranges from one or two up to 100 passengers. Single units or trains may be operated. Speeds are from 10 to +10 miles per hour. Headway (the time interval between vehicles moving along a main route) varies from one or two seconds to a minute. There may be a single route or branching and interconnecting lines.

This definition covers systems with a broad range of characteristics and includes many types of technology. To provide an organizing structure for the assessment, three major categories of AGT systems have been distinguished:

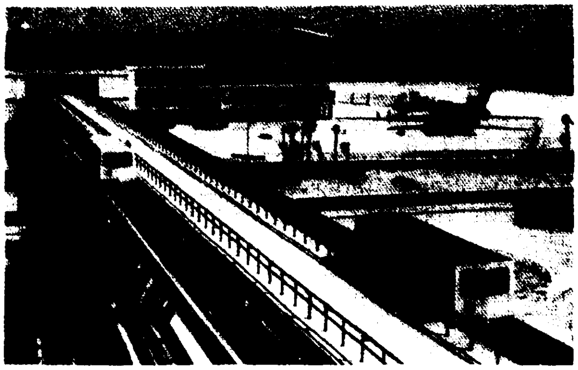
Shuttle-Loop Transit (SLT).
Group Rapid Transit (GRT).
Personal Rapid Transit (PRT).

Definitions and descriptions are given on page 3, with an illustration of each category on the facing age.

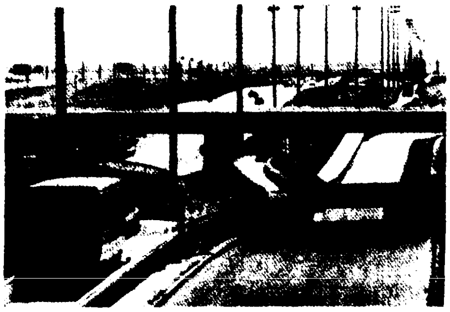
In selecting the terms employed here, care was taken to use those which have already become established in the technical vocabulary. Automated Guideway Transit, Group Rapid Transit, and their acronyms are in general use b the Department of Transportation and the professional community. Personal Rapid Transit is also a common term, but it causes confusion because PRT is sometimes used in a sense that is loosely synonymous with the whole AGT class. Restricting PRT in this report to mean a particular category of AGT is a return to the original definition, given in Tomorrow's *Transportation: New Systems for the Urban Future*, where the term was first used. Shuttle-Loop Transit is a new term, adopted here to describe a type of AGT system for which there is no generally accepted designation

CLASSES OF AUTOMATED GUIDEWAY TRANSIT

Shuttle-Loop Transit
- simplest technology
- vehicle size varies
- little or no switching
- ***long headway-*** seconds or more



Passenger Shu



AIRTRANS-Dallas/Ft. Worth Airport

Group Rapid Transit
- more than six riders
- switching to shorten en route delays
- intermediate ***headway—three*** to *60* seconds

Personal Rapid Transit
- one to six riders
- no en route delays or transfers
- short headway—less than three seconds

Cabinentaxi-Hagen, W. Germany

Shuttle-Loop Transit (SLT).—(Example: Tampa International Airport.) This is the simplest type of AGT system. Vehicles move along fixed paths with few or no switches, The vehicles of a simple *shuttle* system move back and forth on a single guideway, the horizontal equivalent of an automatic elevator. They may or may not make intermediate stops. Vehicles in a loop system move around a closed path, stopping at any number of stations. In both shuttle and loop systems, the vehicles may vary considerably in size and may travel singly or coupled together in trains.

Group Rapid Transit (GRT).—(Example: AIRTRANS, Dallas/Fort Worth Airport,) These systems serve groups of people with similar origins and destinations, The principal differences between GRT and the simpler SLT are that GRT tends to have shorter headways and a more extensive use of switching. GRT stations may be located on sidings off the main guideway, permitting through traffic to bypass. GRT guideways may merge or divide into branch lines to provide service on a variety- of routes. Vehicles with a capacity of 10 to 50 passengers may" be operated singly or in trains. Headways range from 3 to 60 seconds.

Personal Rapid Transit (PRT).—(Example: Cabinentaxi in Germany is a prototype.; there are no systems in passenger service,) The term PRT, as used in this study, is restricted to systems with small vehicles carrying either one person or groups of up to six usually traveling together by choice. Plans for PRT systems typically include off-line stations connected by a guideway' network. Under computer control, vehicles switch at guideway intersections so as to follow the shortest uncontested path from origin to destination without intermediate stops, Most proposed PRT systems call for vehicles to be operated at headways of three seconds or less.

54-370 O - 75 - 2

SHUTTLE-LOOP TRANSIT (SLT)

STATUS

In the United States there are nine SLT systems in operation and six more under construction. Two SLTs stems are operating abroad—one in Japan and the other in France. Five companies in the United States have been involved in producing vehicles for SLT systems. Westinghouse Electric and Ford Motor Company build fairly large vehicles (20 to 100 passengers each). Rohr and Universal Mobility build smaller and slower vehicles in the eight to 12 passenger range whch operate in trains of varying length. A fifth company, Stanray - Pacific, built one system for Baniff International at Love Field in Dallas, Texas.

None of these initial SLT systems serves the general public in the urban environment. All are found in airports, recreational centers, and private commercial establishments. However, SLT has several potential applications as an urban transportation system:

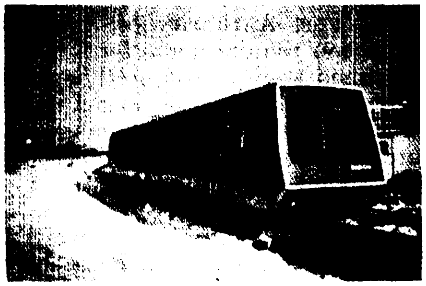
- Circulation in central business districts and other areas where surface congestion impedes movement;
- Collection and distribution of passengers from transit and commuter railway stations;
- Movement of people between remote parking facilities and centers of activity, such as terminals, central business districts or university campuses;
- Connection of two or more major activities, such as a hotel and a convention center;
- Intermediate capacity corridor service, where transfers are acceptable and no switching is involved.

ISSUES

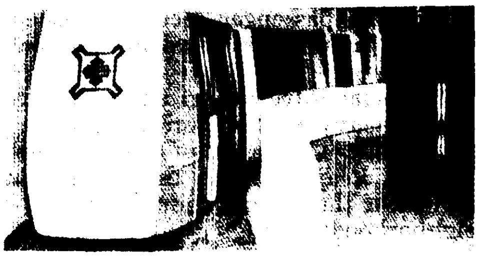
Technical. The SLT systems operating in the United States have provided highly satisfactory service. They have carried a proximately 200 million passengers with only one serious accident. The experience accumulated in building and operating the present systems has served to eliminate most of the technical problems. However, all systems developed so far have been used in special situation:, and there are some basic questions that must be addressed in considering SLT for deployment m an urban setting.

TYPICAL SLT SYSTEMS

Ford Motor Company
Vehicle for
Bradley International
Airport



Universal Mobility
Hershey Amusement Park
Hershey, Pennsylvania



Rohr Industries
Monotrain at Houston
Intercontinental Airport

- Can inexpensive and aesthetically pleasing guideways and stations be built?
- Can operational problems due to snow and ice be overcome inexpensively?
- How can reliability of components be improved at reasonable cost?
- What level of ride quality is required, and what is the trade-off between Guideway roughness and vehicle suspension?
- h ow is the evacuation of stalled vehicles best accomplished?

Economic.-SLT systems have been in operation long enough to enerat.e significant quantities of capital and operating cost data. However, because most existing installations are not intended to produce revenue, there has been little effort on the part of operators to keep detailed statistics. UMTA has only recently started to compile these data.

Preliminary indications are encouraging but not conclusive. SLT systems can operate with a total workforce (operational, maintenance, and administrative personnel) equivalent to one person or less. Conventional transit bus operations require about two persons per vehicle and specialty bus operations offering 24 hour service, as SLT does, could require as many as three to five persons per vehicle.

The tradeoffs between SLT and manned rail transit systems are less clear. A study conducted by the Port Authority of Allegheny County in Pittsburgh compared manpower requirements for a driverless SLT system with those for a manned trolley system. They SLT system was projected to achieve only a small reduction in manpower (12 positions in a workforce of about 225). Savings in manpower achieved by eliminating the on-board operator were largely offset by a requirement to provide station atteni'ants for the automated SLT line.

Capital costs are heavily dependent upon the amount of exclusive guideway to be constructed. However, to put this cost in perspective, It shoulJbe noted SLT guideway costs appear to be competitive with the construction of exclusive busways.

There are two major economic issues associated with SLT.

- What are the ranges of capital and operating costs for SLT?
- For what applications, and under what conditions, is SLT a cost-effective mode of urban transit compared to other transit options?

Social.-Patronage of existing SLT systems is high, suggesting good public acceptance. However, existing installations serve a captive clientele and do not face the same requirements as public transit. The controlled environment of an airport or a recreation park is far different from an urban center, where passenger security, susceptibility to vandalism and security of right of way are much greater problems.

The SLT guideway may be a visual intrusion in an urban area. Some SLT vehicles are large and heavy and require guideways of approximately eight to ten feet in width. he design of elevated guideways must be carefully considered, keeping mind that even small structures could be objectionable. On the other hand, there may be opportunities for enhancing neighborhoods through good urban design. Careful attention to the architectural features of guideways, introduction of linear parks, and urban development in the area of stations could create a positive and appealing environment.

It appears that further data on public acceptance in urban situations can best be gained from an urban demonstration project, perhap s in an activity center or downtown district. The basic issues to Be addressed include:

- The acceptability of ride and service characteristics,
- Effects o !unmanned operation on passnger security,
- Aesthetics of guideway and station design.

InStitutional.— UMTA has not issued performance standards or criteria which would assist in qualifying the simple SLT systems for capital grants. Without such standards or adequate data for evaluating the economic and social characteristics of SLT, it is difficult to determine cost-effectiveness in relation to other transportation modes, and those reviewing grant applications will continue to be skeptical of their worth. Because UM A requires that system planners substantiate the cost-effectiveness of the mode selected in order to qualify for capital assistance grants, SLT system are placed at a distinct disadvantage.

As a comparatively new technology, SLT is under a second disadvantage. Product engineering and tooling form a large part of the manufacturer's initial costs. These costs must be recovered in the first project or two because a long-term market has not been established.

SLT system research and development to date has been largely financed by private industry. However, there is little incentive for industry to spend additional funds for follow-on development, testing and Product improvement without positive inducement in view of UMTA's negative attitude regarding capital grants for new systems. The government's R & D program also offers little encouragement to pursue SLT since most of the budget is devoted to the more complex classes of AGT.

FINDINGS

- SLT systems appear worthy of careful consideration as transportation alternatives for many specialized urban transportation problems.
- UMTA'S research and development program does not emphasize improvement of technical operating characteristics and reduction of SLT system costs.
- UMTA'S technological R & D is not matched by a corresponding program to develop a better understanding of problems in the area of economics and public acceptance. SLT systems should receive emphasis in such a program.
- **An urban demonstration project for SLT appears justified. Such a project should concentrate on gathering economic and acceptance data and on improving the technical operation of the system.**
- **There is a lack of criteria for qualifyinir SLT systems for capital grant funding. There is no apparent m-echanisfi within UMTA for the trafisfer of R & D results to implementation under the capital grant program.**

GROUP RAPID TRANSIT (GRT)

STATUS

Two AGT s stems have been built in the United States—one at Morgantown, West Virginia, and the other at the Dallas/Fort Worth Airport. There are no operational GRT systems overseas. Three are under construction in Japan, and one was started in Canada but has been temporarily halted.

The Morgantown project is significant because it represents the most ambitious effort thus far to build a full-scale system capable of providing service on demand from origin to destination and to o crate vehicles on 15-second headways in a real life environment. '1he rime contractor, Boeing Aerospace Corporation, has delivered 18 0r the 45 vehicles required under the contract and expects to complete the prescribed acceptance testing in mid-1975.

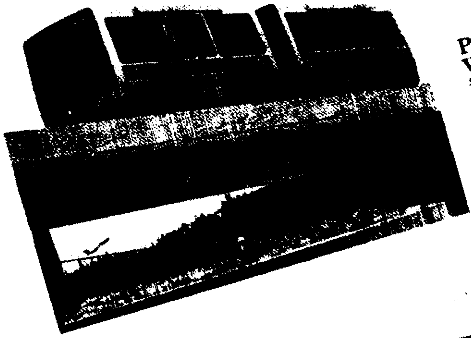
Vehicle and Guideway in Morgantown, West Virginia

The AIRTRANS system, built by the LTV Aeros ace Corporation at the Dallas/Fort Worth Airport, is the largest AGT project yet undertaken. It consists of 13 miles of guideways, 55 stations, 51 passenger vehicles and 17 utility vehicles. The system was designed to handle airline passengers, employees, interline baggage, supplies, airmail, and trash. It was opened to the public in January 1974 and is currently providing inter-terminal passenger and supply service. Most of the non-passenger movements are stall handled by alternate means.

Two major studies in the United States are noteworthy. The Twin Cities Area Metropolitan Transit Commission has recommended AGT as one of three transportation alternatives to be selected for detailed planning . In Denver, the Regional Transportation District has selected GRT as the preferred system for regional deployment. Significant planning for the installation of GRT systems is also taking lace in Japan and Europe.

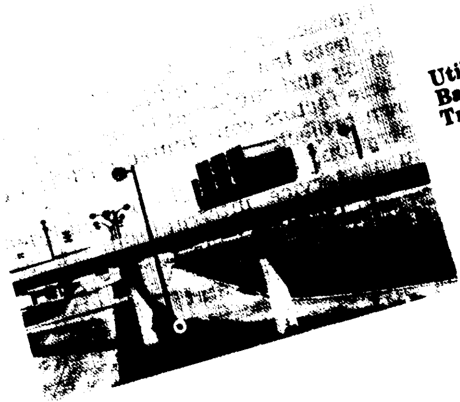
UMTA is seeking funds in fiscal ear 1976 to start construction of a prototype test facility which will carry forward the work accomplished at Morgantown and at Dallas/Fort Worth. This reject, designated by UMTA as "High Performance Personal Rapid Transit" ("HPPRT"), involves 12-passenger vehicles and is really an advanced version of GRT. Contracts for preliminary enginneering have been awarded to Boeing, Rohr and Otis-TTD. UMTA's current

AIRTRANS GRT SYSTEM DALLAS/FT. WORTH AIRPORT



Passenger Vehicles in Tandem

Control Panel Showing System Layout



Utility Vehicle for Baggage, Mail and Trash

plan is to select one of the system concepts developed by these contractors for full-scale testing. A two-mile test track, five prototype vehicles and a sophisticated control system capable of achieving three-second headways will be built and evaluated over a four-year period.

Although the two GRT systems in place serve special transportation situations (an airport and a university), GRT is technically capable of providing basic urban transportation for low- to medium-density traffic. With headways of 15 seconds and capacities of 20 passengers per vehicle such systems could move a maximum of 4800 people per hour.

Along more heavily traveled routes, capacity can be increased by using larger vehicles, coupling two or more vehicles together, or by reducing headways. GRT is thus viewed as an intermediate capacity system, i.e., less capacity than rail rapid transit but more than typical bus operations. In this sense, GRT is much like light rail transit.

The potential for evolution to greater capacity and versatility through technological advances is an important consideration. A relatively simple GRT system can be installed at the outset and later expanded with off-line stations and shorter headways—using the same technology and without redesigning the basic guideway network.

ISSUES

Technical.-Both the Morgantown project and the AIRTRANS system have experienced numerous technical problems. In the case of Morgantown, a complete redesign has recently been completed. AIRTRANS has not yet been finally accepted by the airport. Of course, problems should always be anticipated in the development and introduction of new technologies, but GRT has suffered from a lack of research and development prior to deployment, the restrictions of fixed rice contracts, and management problems.

The General Accounting Office has recently completed a detailed review of the cost, schedule and performance characteristics of the Morgantown Project. Since the GAO staff study has been transmitted separately to the Congress, it is unnecessary to cover the same ground in this report. It is sufficient to note that an ambitious R & D effort was attempted in an urban setting and subjected to unrealistic deadlines and design criteria. All these factors contributed significantly to the high cost of the Morgantown project.

During the first year of operation, AIRTRANS was plagued by equipment failures and frequent service interruptions. In recent months, however, reliability has improved significantly; and LTV has been able to cut the maintenance force in half. Nevertheless, the airport management keeps buses in standby status for use when service interruptions exceed 15 minutes. In the first three months of 1975 the buses were called out five times because of AIRTRANS failures.

The safety record of the system has been good. Reliability has steadily improved, with system availability at 100 percent during a recent six-week period. Originally, a maintenance force of 90 was anticipated for the project; but 120 are currently employed, down from a peak of about 250.

B asic technical issues cited earlier for SLT applv to GRT as well. There are also the following issues specific to GRT'~

- Does greater system complexity contribute to a more difficult reliability problem?
- Are there alternative engineering concepts that can reduce the cost of GRT systems?
- Can ride quality (particularly freedom from sway and jerk) be improved over that of AI RTRANS and Morgantown?

The advanced GRT program being undertaken by UMTA ("HPPRT") raises two additional technical concerns. "

. Reduced headways require demonstration of the feasibility of command and control systems.

. Software must be developed for managing a larger fleet of vehicles.

Economic.-The two GRT systems constructed have been expensive. AIRTRANS, originally projected at $35 million, is now reported to have cost over $53 million. The cost of the Morgantown system was initially estimated at $18 million by West Virginia University in 1970. The detailed estimate by the Jet Propulsion Laboratory in 1971 was $37 million. So far the project has cost $64 million for a system half as large as Initially contemplated. Even allowing a generous amount for one-time R & D charges, these systems have proved very costly for the amount of service that they can provide.

Conclusive data on operations and maintenance costs of GRT systems are not available. The first year of AIRTRANS has been a shake-down phase with costs substantially higher than could be expected for normal operation. At current manning levels, AIRTRANS averages about 2.5 people per vehicle, or 25 percent more than the Washington Metropolitan Area Transit Authority METROBUS operation.

The economic issues are straightforward.

- Is there a market for GRT systems or a transit "need" which they would serve?
- Assuming they fill a need, are GRT systems cost-effective competitors in the urban transit market?
- can the Morgantown and AIRTRANS projects be used by UMTA to gather data on GRT operating and maintenance costs?
- Is there any justification for hardware R & D (i.e., the "HPPRT" program) before first gathering economic data such as that described above?

Soctial.-GRT requires large, elevated, exclusive guideways that present the same problems of visual intrusion as SLT and offer the same opportunities for urban improvement. Because GRT is more complex than SLT, problems of safety- and security are accentuated.

The AIRTRANS experience suggests that automated systems, because of the inherent inflexibility of machine operations, require a higher degree of passenger understanding and cooperation than do manned systems. Airport employees and other AIRTRANS patrons have at times disrupted operations by opening doors, or holding them open, thereby causing the system to shut down. Also, the system lacks good human engineering. Information is so poorly conveyed that patrons become confused and frustrated. To compensate, it has been necessary to add attendants in stations.

Experience with Morgantown and AIRTRANS indicates the following needs.

. These two systems should be carefully monitored to obtain data relating to public acceptance.

. Human engineering principles must be applied to facilitate the patrons' use of the system.

1nstitutional.-UMTA has put nearly all of the total $95 million spent on AGT research and development into GRT. However, it has concentrated on technical hardware development with little consideration of social needs and economic considerations. As a result, understanding of the potential role of GRT is incomplete. UMTA does not have a demonstration program for GRT systems in an urban situation. This should be corrected, articularly if further investment in GRT system R & D is made. T fe discussion of the issues under SLT applies to GRT as well.

FINDINGS

- **A number of localMes across the country have shown interest in installing GRT systems,**
- **Serious technical problems have arisen in the first two installations and neither is yet operating as planned. These technical problems have been exacerbated by unrealistic** deadlines and management problems.
- UMTA's R & D Program does not include **market and economic** research sufficient to evaluate the **need for** GRT and its cost-effectiveness as a solution to urban transportation problems.
- Monitoring efforts for AIRTRANS and Morgantown are required to obtain data useful in evaluating GRT. UMTA could perform this service and **has** initiated **such a program for AIRTRANS.**
- **Until the Morgantown system has been proved in actual operation, it would be premature to commit funds to expand the system. Additional funding does seem justified to complete the engineering work which is necessary to develop realistic cost estimates. Federal assistance for this interim operating period may be appropriate if the partial system places a greater financial burden on the university than the full system would have.**
- **No clear urban transportation need is apparent for the short three-second headway Performance ?mecified for the "HPPRT" mogram. The mogram should be reviewed to ~ee whether modifications wo~ld not incr_eas= its value.**

POTENTIAL ROLE OF PERSONAL RAPID TRANSIT (PRT)

STATUS

Since the term "Personal Rapid Transit" tit entered the transit vocabula~ in 1968, this high] innovative conce t has fascinated many transportation planners. $ RT offers personaYized service with small vehicles which rovide non-stop transportation from origin to destination at short feadways. To date, no systems which can be classfied as PRT are in revenue service or under construction in the United States, but several test tracIc installations have been built in Europe and in Japan.

Proponents of PRT view this concept as a reasonable supplement to the private automobile in high density urban areas [1] and claim that PRT can provide a very much higher level of service than other modes of public transportation. Thus, it is argued that PRT systems would attract a significant percentage of the rides now being made in private automobiles and offer obvious benefits:

- less traffic congestion in urban areas.
- less land and fewer facilities used for automobile storage.
- reduced travel time under more comfortable Circumstance=.
- less noise and air pollution.
- reduction in consumption of petroleum-derived fuels.
- reduction in requirements for new arterial roads and urban freeways.

It is contended that PRT would provide greater mobility for the transportation disadvantaged, i.e., the young, the elderly, the poor, and the handicapped.

Proponents admit that the area-wide networks with closely spaced stations and large numbers of vehicles would be expensive to build and, perhaps, to operate. The initial capital cost might equal that of rail rapid transit systems, but levels of service are envisaged to be much higher than with conventional modes, except perhaps taxicabs. Proponents claim the higher service levels will attract significantly greater patronage than conventional transit. Automation is expected to allow the high service level to be delivered at a cost the public is willing to pay.

PRT capacity depends upon short headways. Except in downtown areas, headways need not be closer than those of GRT systems (i.e., three seconds). In downtown areas, headways on the order of ½ second would be needed to move 10,000 people per hour over a single PRT guideway at an average occupancy of 1.4 people per vehicle. This is roughly equivalent to the number of people moved on four freeway lanes.

Advocates of PRT estimated that there are 10,000 square miles of urban areas in the United States where PRT service might be appropriate. This would require about 20,000 miles of one-way guideways and about three million PRT vehicles.

ISSUES

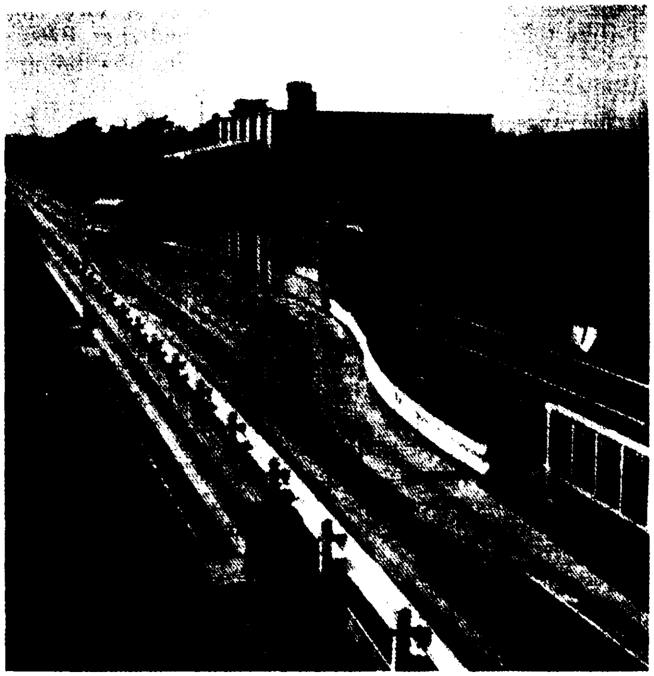
Because there are no operating systems, there is no empirical evidence on PRT. Many of the studies reviewed were motivated by attempts to sell or reject the concept and were based upon largely arbitrary assumptions. Therefore, there are many detailed issues for which objective data are needed.

Technical.—With few exceptions, the engineers and manufacturers who have made serious studies of the PRT concept find that there are numerous technical problems that must be solved before PRT systems can be deployed. Technical solutions have been proposed but not validated, and a large program of development, testing and demonstration would be needed to implement a PRT system. Estimates of time and money required to achieve market-ready systems vary widely. However, there appears to be general agreement that at least 10 years would be required depending upon the level of funding provided.

---

[1] Greater than 3,000 people per square mile.

PRT TEST FACILITIES ABROAD



CVS, **Higashimurayamz Tokyo, Japan**

ARAIMI~ Orly Airport, Paris, France

The following technical problems need to be solved.

- Computer control systems must be developed to exercise command and surveillance over thousands of vehicles traveling between hundreds of stations at fractional-second headways. Vehicle management (particularly the storage of empty vehicles and their redistribution to satisfy changes in demand) further complicates this problem.
- Advanced control and braking systems must be perfected to insure that vehicles can be operated safely at very close intervals.
- Major improvements in reliability—far beyond those levels which have been achieved for any transit equipment in operation—are required. Engineering techniques from other fields may be applicable to this problem.
- Crash survivability should be demonstrated for PRT, possibly using techniques similar to those required for automobiles by the National Highway Traffic Safety Administration. Means for emergency evacuation should be provided to insure passenger safety in the event of a failure.
- Study of alternative engineering approaches is required to develop cost-effective systems and components.

Economic.—The economic characteristics of PRT are so unclear that meaningful analysis is difficult. Several analyses have been attempted, including one by the Aerospace Corporation for the Los Angeles area, a general study by the DOT Transportation Systems Center (TSC), and one of the Twin Cities area by De Leuw Cather. Cost assumptions vary reatly. Proponents' estimates for PRT vehicles, for example, are Based upon large production runs, and the estimated cost per unit presumably goes down with increased production. As another example, costs are related to solutions to potential social problems. If passenger security considerations require the installation of closed circuit T.V. throughout the system, including vehicles, then the ccsts would rise appreciably. Costs for operation and maintenance also vary. Proponents' estimates assume maintenance levels that are unrealistically low for transit.

- The major economic issue is whether research, without hardware development and urban demonstration, can answer the economic questions, or whether hardware development is necessary to assess the economic characteristics of PRT systems.

Social.—Public acceptance of PRT is open to question. Despite the many potential advantages of PRT in comparison to other transit modes, there is serious question that the associated proliferation of elevated guideways and stations would be acceptable to the public, particularly in residential neighborhoods. Also, the safety and security aspects of unattended small vehicles require careful evaluation.

Advocates contend that PRT should duplicate as closely as possible the service characteristics of the private automobile. The wisdom of attempting to provide such a high level of service at public expense is open to question. Whether the benefits of such a system would only accrue to the well-to-do, or whether they would also provide for the needs of the transit disadvantaged is worthy of exploration. An annual expenditure equal to the debt service on the capital cost of such a high technology system, when combined with traffic management systems designed to enhance conventional transit, might provide better service at lower cost over a larger service area than PRT. These observations may be equally true for other capital intensive systems. Such tradeoff studies should be undertaken and clear urban transit goals articulated by UMTA before the agency embarks on new systems for their own sake.

The major social issues of PRT are summarized below.

- What urban objectives will be served by a PRT system?
- What is the overall social acceptability of PRT, and what lessons can be learned from less sophisticated AGT systems?
- Can PRT systems offer adequate passenger security, particularly in numerous unattended stations?
- What environmental impact will guideways and stations have on the neighborhood?

Institutional.—Groups in Germany, Japan and France are actively engaged in PRT research and development. The possibility of cooperative arrangements between United States firms or the United States Government and their overseas counterparts thus exists. Such efforts, building upon United States experience and accomplishments in SLT and GRT and overseas research in PRT, could lead to stronger and more cost-effective development programs. On the other hand, the United States has pioneered much of the work in new transportation systems and could develop the technology if a need exists for PRT.

The effect on U.S. balance of payments must be considered if equipment licenses or royalty payments for the use of foreign patents are required. Such payments, however, will be only a small part of the costs for building a system because most transit system costs are for construction. Thus, potential foreign exchange savings are too small to justify a large investment in domestic R. & D.

PRT poses major institutional issues.

- Should PRT systems be a substantial part of UMTA's R & D effort?
- Should other arrangements be considered for PRT development and deployment?
- To what extent is international cooperation possible and beneficial?

FINDINGS

- **Before major commitments of funds are made for detailed simulations or hardware developments, research is required to resolve the many uncertainties concerning the proper role of PRT systems, their social acceptability and their economic feasibility. These preliminary studies may involve expenditures of $4 to $6 million.**
- **There are possibilities for cooperation with foreign governments or overseas suppliers in research and development of PRT. UMTA has recognized these possibilities in starting negotiations with the West German Government.**

U.S. Government Research and Development of AGT Systems

R & D PROGRAMS

Since 1962, UMTA has spent about $95 million for R & D on AGT systems. Two-thirds of the Westinghouse Transit Expressway demonstration project was government-financed from 1963 onward. Federal R & D funds (about $4.5 million) assisted developments which ultimately led to installation of four SLT systems. The most expensive project undertaken by UMTA during this period was the Morgantown GRT demonstration project which has cost $64 million. Other significant undertakings were development of two prototype vehicles for the Dallas/Fort Worth Airport at about $1 million and demonstration and evaluation of four Transpo-72 peoplemover systems involving almost $10 million. Considering the substantial amounts expended since the establishment of UMTA, accomplishments in the form of fully developed systems in revenue service have been limited. Most of the systems now in operation did not receive direct federal R & D funding. Indirectly, however, the federal R & D program has stimulated major manufacturers to develop and demonstrate AGT systems.

In the budget request for fiscal year 1976, UMTA is seeking $14 million in R & D funds for AGT systems (about 40 percent of the total R & D budget of $37 million).

- $10 million is requested for detailed engineering, urban deployability studies, and the first phase of construction of a new prototype test and evaluation facility. This project, called "High Performance Personal Rapid Transit (HPPRT)", deals with an advanced form of Group Rapid Transit. The total cost for five prototype vehicles, the test facility, and a comprehensive evaluation program is estimated by UMTA at somewhat more than $30 million over a four year period.
- $4 million is requested for the "Automated Guideway Transit Technology Program". (To this will be added $4.4 million of reprogrammed FY 1975 funds, making a total of $8.4 million.) Unlike the "HPPRT" project, which deals with a specific new system, this program will provide for selective R & D on components and special problems which are common to a number of AGT systems.

Considering the substantial amount of transportation hardware being purchased under the capital grant program, the funds allocated for R & D to perfect alternative new solutions to urban transportation problems are small. In FY 1975, R & D expenditures by UMTA amounted to only 1.9 percent of total expenditures. For FY 1976, the $37 million requested is 2.1 percent of the projected total. In contrast, the total budget of the United States for FY 1976 allocates 5.7 percent of all federal spending to R & D. It is clear that UMTA lags well behind the government average. R & D for urban mass transportation amounts to only about 7 percent of all federally sponsored R & D for transportation, yet 76 percent of all passenger trips are in urban areas.

UMTA needs to clarify the scope and objectives of the AGT Technology Program. Solving all the problems posed by AGT would require several multiples of the proposed budget. Priorities have to be established to give proper balance to solving near-term technical problems in conventional transit modes and the simpler forms of AGT, while laying the groundwork necessary for advancing the basic technology of AGT.

RELATIONSHIP OF (GOVERNMENT AND INDUSTRY R & D

Major manufacturers report aggregate expenditures from company funds of about $100 million for AGT research and development. Industry was willing to make this investment in anticipation of a substantial market for AGT equipment. However, no such market has developed, and most of the manufacturers are pessimistic about the future. Two major manufacturers, Bendix and Pullman, have withdrawn; and others are considering termination of their AGT programs. In this atmosphere it is unrealistic to expect that industry will make further substantial investments for product development and improvement.

Federally sponsored R & D has not included a coordinated program for conversion of successful products into operational systems. This may be partially due to uncertainty about the value of new systems. Another reason may be the complex requirements surrounding government-sponsored research. Finally, institutional failures may have hindered implementation. If broad application of AGT systems is desired, there are other mechanisms that could be employed.

- The provincial government of Ontario, has established the Urban Transportation Development Corporation (UTDC) to aggregate the market for system installations, license foreign developments, test prototypes, and market new urban transportation systems.
- In France, system suppliers are selected early in the planning process and work closely with public officials in planning and developing a system installation.
- System development in Japan is accomplished through a business-government cartel. Fixed facilities constructed on public streets are financed by gasoline taxes; other costs are shared by the participants.
- In the United States, the Communications Satellite Act of 1962 established a corporation (COMSAT) to develop, implement, and operate a telecommunications satellite system.
- Also in the United States, the Transit Development Corporation (TDC) has been formed as the scientific and educational agency of the transit industry. It could function much as the President's Conference Committee did in the 1930's in bringing operators and suppliers together on new developments.

FINDINGS

- **UMTA's R & D programs for new systems have emphasized advancing the state of technology but have neglected near-term system improvements to perfect and apply simpler approaches to correct transit problems.**
- **Better results might be achieved from cooperative arrangements between government and industry.**
- **The scope and objectives of UMTA's AGT Technology Program need to be clarified.**
- **Transit research and development is receiving a disproportionately small share of federal R & D funds.**

BUDGET ALTERNATIVES FOR FISCAL YEAR 1976

BACKGROUND

Automated Guideway Transit has a variety of potential applications for urban transportation that are worth pursuing. The SLT systems are in a more advanced state of development than other classes of AGT systems. They are especially appropriate for activity centers and as circulation systems for downtown areas.

The GRT systems are less developed than the SLT systems. The two installations in Dallas/Ft. Worth Airport and Morgantown have been marred by technical and managerial problems. However, valuable experience can be obtained from both of these programs. The more advanced GRT systems, under development by UMTA through the "HPPRT" program, have potentially higher service levels than the AIRTRANS-Morgantown equipment, but their economic and technical feasibility remains to be demonstrated.

PRT has the highest potential service level and may have the highest patronage level of all AGT systems. However, it poses the most difficult technical problems and requires both hardware development and study concerning service level, patronage and economic feasibility.

Application of resources for the development of all three types of AGT is warranted. The distribution of funding among them, however, is a matter of debate. Four budget alternatives for the coming fiscal year are outlined below.

ANALYSIS OF BUDGET ALTERNATIVES

The budget submitted by UMTA for FY 1976 contains provisions for a program of AGT research and development totaling $18.4 million, of which $14 million is new (NOA) funding and $4.4 million is carry-over funds. The proposed R & D program has two major elements: the "HPPRT" program ($10 million) and AGT Technology ($8.4 million). The program concentrates heavily on development of technology and feasibility demonstrations. Almost no effort is allocated to study the social and economic aspects of AGT.

Four courses of action on the program budgeted for FY 1976 are worthy of consideration by the Congress. They are listed below and summarized in tabular form. An analysis of each alternative is presented afterward.

Alternative A—Approve the program as submitted.

Alternative B—Provide no new funding and use carry-over funds for a reduced program of data gathering and analysis.

Alternative C—Approve the level of funding requested by UMTA but restructure the program.

Alternative D—Increase the level of funding and expand the scope of the proposed program.

Funding Alternatives Fiscal Year 1976

[In millions of dollars]

	No change (A)	Reduce (B)	Restructure (C)	Expand (D)
HPPRT	10.0		6.0	15.0
AGT technology:				
New funds (NOA)	4.0			12.0
Carryover	4.4	4.4	:::	4.4
Social/economic impact studies			2.0	3.0
Total funding level (NOA and carryover)	18.4	4.4	18.4	34.4

54-370 O - 75 - 3

ALTERNATIVE A—APPROVE THE PROGRAM AS SUBMITTED

This alternative would provide a total funding level of $18.4 million (including $4.4 million of carry-over funds) of which $10 million would be allocated to the "HPPRT" program and $8.4 million to AGT Technology. This action would:

- Continue the current emphasis on high technology R & D, notably "HPPRT".
- Leave to private enterprise most of the cost of product improvement for near-term applications of SLT and GRT in urban environments.
- Require continuing appropriations to complete the "HPPRT" test program and to achieve market-ready status.
- Leave unresolved the social and economic issues relating to AGT systems, particularly PRT.

ALTERNATIVE B—PROVIDE NO NEW FUNDING AND USE CARRY-OVER FUNDS FOR A REDUCED PROGRAM

This alternative would provide no new funding for AGT research and development and would restrict the budget to carry-over funds from FY 1975 and prior years. Carry-over funds would support a program of data gathering and analysis for existing AGT systems (SLT and GRT). This action would have the following consequences:

- Curtail the development of AGT technology and limit the options available to urban transportation planners.
- Cause more companies to restrict or abandon further AGT development.
- Make the United States dependent on foreign technology and manufacturers for new AGT systems.
- Give priority to analysis of data on existing systems before proceeding further with new technology development.

ALTERNATIVE C—APPROVE THE REQUESTED LEVEL OF FUNDING BUT RESTRUCTURE THE PROGRAM

This alternative would approve the $18.4 million level of funding requested by UMTA ($14 million NOA, $4.4 million carry-over), but with restructuring of the R & D program. Funding for the "HPPRT" program would be reduced from the proposed $10 million to $6 million. The AGT Technology program would receive increased funding ($6 million NOA, $4.4 carry-over) to permit greater emphasis on evaluating AGT technologies. Two million dollars would be allocated for the study of social and economic factors, an area that has been neglected in UMTA R & D programs up to now. The restructuring of the program would:

- Redirect the emphasis of R & D toward exploiting existing technology.
- Involve UMTA in product development and improvement, which have traditionally been private industry activities.
- Provide data to further an understanding of the social and economic implications of AGT.

- Entail a commitment to continue substantial R & D funding for AGT systems.
- Require substantial expansion and improvement of R & D management capability in UMTA.
- Continue active participation by three manufacturers through the completion of the "HPPRT" prototype testing phase to facilitate urban applications.
- Require better coordination between the R & D and capital grants programs.
- Encourage industry to bear pre-production engineering and tooling costs.
- Probably stimulate more requests for capital assistance to plan and install AGT systems.
- Give adequate attention to the heretofore neglected social and economic impacts of AGT.