REPORT OF THE PANEL ON INTERNATIONAL DEVELOPMENTS

Prepared for the Office of Technology Assessment

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CONTENTS

Introduction

This assessment of international developments in automated guideway transit has been accomplished by:

- First, a panel whose members have visited and studied foreign developments, then discussed and reported on their findings. Biographic sketches of the panel members are included in Appendix A.
- Second, the willing cooperation of officials in foreign governments and industries who have shared their knowledge with the panel. The invaluable contributions from these individuals are acknowledged in Appendix B.

The panel also appreciates the assistance of many others who have contributed to this effort. particularly:

- Mlyron B. Kratzer, Counselor for Scientific and Technological Affairs, U.S. Embassy; Tokyo, Japan.
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- Dr. Geurt Hupkes, Vice President, Center for Transportation Planning; Utrecht, The Netherlands.
- Namiki Oka, Chief Transportation Editor, Asahi Shimbun, Tokyo, Japan.

Chapter 1: History of Foreign Interests

Much of the impeus for foreign development of Automated Guideway Transit (AGT) stems from a study of new transportation systems initiated by the United States Congress in 1966. The resulting report, *Tomorrow's Transportation, New Systems for the Urban Future,* was submitted by. the President, to the Congress in May, 1968. It has been translated into French, German, and Japanese. This report, and the related back-up studies, are generally credited with providing the incentive for developing new transportation systems in those three countries.

Foreign research on the technology that was to become a part of these systems began much earlier. For instance, the Krauss-Maffei work on magnetic attractive levitation began in the early 1960's and was based on research by Professor H. Kemper initiated in 1935. A French engineer, Emile Bachelet, built a small demonstration transport system using magnetic levitation and propulsion in 1912. Serious work on electric linear induction motors for transportation use began with the publication of E. R. Laithwaites' book, *Induction Machines for Special Purposes,* in 1966 at the Imperial College, London.

The combination of technologies into new transportation concepts commenced in earnest in 1968. Tokyo University began planning for the Japanese Computer-controllecl Vehicle System (CVS) in that year. The computer control logic, using a "traffic game", was demonstrated at the World Exposition in Osaka from March to September of 1970. The French government began assisting several private developers in 197. German industry commenced research and development of AGT systems in 197o. The Federal Ministry of Research and Technology has shared in the cost of this development since 1972.

Development of an AGT system in Great Britain preceded the U.S. New Systems Study. Such a system, "Cabtrack," was conceptualized by L. R. Blake of the Brush Electrical Company in 1966. This work was inspired by a trip to the United States where Blake became acquainted with pioneering efforts with the staRRcar, Urbmobile and Teletrans.

Interest in Great Britain was also crystallized with the publication in 1.966 of Brian Richard's book: New *Movements in Cities.*

Chapter 2: Requirements and Opportunities

The incentive for foreign development of AGT' systems originated from several sources. Cities in Europe and ,Japan have not adapted well to the private automobile. Street congestion has reduced the efficiency and use of trams and buses. The high cost of building and operating heavy rail rapid transit systems has hindered plans for future installations of this mode. These problems, coupled with advantages perceived for AGT systems, have prompted the development of 18 foreign systems and commensurate planning for their installation.

DEFICIENCIES IN PRESENT TRANSPORTATION SYSTEMS

Most major cities throughout the world are faced with the same general problems: rush-hour street congestion, mass transit overcrowding in peak periods and underutilization during off-peak hours, deteriorating bus service, increasing traffic accidents, noise and air pollution, and continually rising transit costs. The ubiquitous automobile has been at the center of the cause and effect of most these problems.

PRIVATE .4 ATOMOB1LES

The foreign popularity of private automobiles as preferred personal transportation did not emerge until the 1950's. While owners were were quick to take advantage of new-found mobility, city officials were slow in anticipating the long-range consequences of increased motor vehicle use. The urban form, pattern and size of city- streets in Europe and ,Japan were established long before the advent of motor vehicles. Provision of roads and parking has not kept pace with motorization. In Western Europe, for example, the number of cars per 1,000 persons increased from 68 in 1960 to 174 in 1970. During the same period in Japan, car ownership in increased from five to 85 per 1,000 persons. Adaptation to such increases has been difficult. find in the process has eroded much of what was once described as old world charm".

Ancient buildings have been damaged by passing motor trucks and automobiles-m have been destroyed to make way-for roads and parking structures. The automobile population in Paris covers more area than till her road surface, thus, the tree-lined medians and sidewalks become parking lots at night. The din of automobile horns in Paris has been quieted in recent years by- strictly enforced codes. The high level of traffic accidents are universally cited as a major urban problem to be addressed by new transit systems. Injury accidents per 100-million vehicle-kilometers in 1970 were 126 in France, 139 in West Germany and 390 in Japan in 1969. Automobile air pollution is regarded as the cause of extensive illness among school children in Tokyo. Chronic traffic jams and limited parking spaces have reduced the usefulness of private automobiles for transportation in major Japanese cities. Recent advertising campaigns by automobile agencies in Japan stress the comfort, air conditioning and entertainment within the private space of an automobile, but not the convenience of trip taking. These problems and the related environmental deterioration have caused serious social and political problems.

on the other hand, motor vehicles have provided a range of independent mobility and service unknown previously'. In England, the limited degree of private car ownership now (3.6 persons per car) and in the future is a major reason for the need of public transport. Yet, the present level of car ownership is the major cause of traffic congestion and reduced efficiency oF public transport, The increasing dependence on automobile transportation in Germany is shown by the following:

- In 1950, travel amounted to a little more than one trip per person per day and 70 percent of this travel was by public transit.
- By 1970, travel doubled to nearly two trips per person per day, with 75 percent by private automobile and only 25 percent by public transit.

Freight movement also depends heavily upon motor carriers. For example, in Japan in 1973, 93.6 percent of all freight was moved by motor vehicles. In Japanese urban areas, 50 percent of all traffic is truck movement. Delivery trucks and service vehicles are a major source of street congestion, but functions performed by these vehicles are not performed by public transportation systems.

Greater reliance on motor vehicles for private transportation has affected public transportation in two ways. First, the increased amount of urban travel performed in private automobiles has diverted transit patrons. Private automobiles enabled large sections of the population to move to the fringes of cities where thinl~' populated areas could not be served by mass transit. As a consequence, public transport has suffered a proportionate and absolute decline in usage. The following German experience illustrates the loss of attractiveness in spite of reliable service and good networks:

- Transit supply capcity increased from 9.5 million passenger-km per day ii 1960 to nearly 15 million passenger-km per day in 1970.
- During this same period, the load factor dropped from 32 to 17 percent.

,Second, street congestion has reduced running speeds and has made accurate scheduling for surface transit impossible. For example, in West Germany 80 percent of urban public transportation is provided by buses and trams which operate in the same space as private automobiles and motor trucks. Typical traffic speeds averge 28 km/hr (17 mph). The average speed of a Paris bus declined from 15 km/hr (9 mph) in 1959 to 9.5 km/hr (5.7 mph) in 1968. The decline in use and usefulness of public transit has forced operators to curtail services and raise fares (or obtain larger subsidies).

In addition to the impact of the private automobile discussed above, other deficiencies in present transportation systems have prompted the development of automated guideway systems. Some of these other deficiencies are discussed below.

BUSES

Except for taxicabs, buses are the most labor intensive form of public transportation. Between 70 and 80 percent of bus system operating costs are for labor. Escalating personnel expenses result in higher fares or larger subsidies and add to the general inflation. In recent years, transit operators have had difficulty recruiting and retaining staff. For example, in recent years as much as 20 to 30 percent of London Transport equipment has been out of service during peak hours due to the lack of operating personnel. This situation is being corrected through an aggressive job enhancement program, a wage increase and the depressed state of other employment opportunities. Nevertheless, there is less willingness to work the awkward times necessary to keep a public service operating 18 hours a day.

Buses operating on exclusive rights of way or on priority lanes have been successful in attracting and increasing ridership. Dial-a-Bus systems have also filled a gap in public transportation services. However, initial experiments with these systems have found that the~ are expensive to operate. A demonstration project in North Toronto was discontinued after six months, even though one-third of the patrons were automobile users who previously. did not use transit. More research and experimentation is needed on exclusive and demand responsive bus services in order to successfully tailor their use to specific community. needs.

LIGHT RAIL TRANSIT

Of the conventional public transportation modes, light rail transit (LRT) offers the service characteristics which most closely approximate SLT and GRT systems. Nevertheless, LRT also has deficiencies which justify a search for improved alternatives.

LRT, or trams, running on city streets are subjected to delays from traffic congestion, as discussed above. Left turns at busy intersections contribute to the congestion. Patrons crossing streets to and from loading points are subjected to traffic hazards. Dedicated rights of ways can avoid some of these problems, can be made attractive, and are thus more acceptable to the neighborhoods they traverse.

LRT is labor intensive, though not as much so as bus transit. A typical 4-axle tram can seat 32 and has a total capacity of 110 with standees. For a 6-axle LRT, these capacities become 43 and 158 respectively. Thus, the passenger-driver ratio is about twice that of a bus. New articulated, three-car vehicles can provide 94 seats and a total capacity of 254. The addition of an unmanned, non-powered trailer (as used in Hong Kong) can add 150 to the capacity. At 400 passengers per operator, the tram becomes one-fifth as labor intensive as a bus.

LRT is also subject to the same labor problems as other conventional modes. Split shifts, double shifts or overtime are necessary to cover the morning and evening peaks. LRT does have the advantage of being able to add equipment, without necessarily adding operators, to meet peak-hour demands.

Other objections to LRT include the obtrusive overhead catenaries for power. A third rail on dedicated rights of way can remove this objection, but a trough for power collection on city streets (once used in Washington, D. C.) presents formidable maintenance problems. Noise and limited ability to climb grades are also cited as disadvantages.

The deficiencies discussed above are generally regarded as the reasons for shifting to other forms of public transportation. All but three tramways have been abandoned in France. There is a resurgence of interest throughout the world in LRT, particularly where tramways or other rights of way exist. On a trip to four European countries m January, one panel correspondent visited 32 cities where light rail or pre-metro systems are being upgraded or extended. Even where totally new systems are contemplated, LRT is being evaluated as one alternative to new forms of automated guideway transit.

Proponents of LRT contend that research and development on this form of transit could bring significant advances in performance. It has been suggested that LRT could be fully automated for segregated routes. Vehicles could be made smaller for higher frequency routes when automation becomes operational. R & D could help reduce the costs of construction and operation. Reductions in vehicle weight would lower energy consumption, noise and vehicle costs. The result of this R & D would be a public transit system comparable to the SLT and GRT systems being assessed by this report. Only a semantic difference would remain.

RAIL RAPID TRANSIT

Heavy rail rapid transit systems, such as the London Underground, do not provide the fine mesh transport offered by bus systems. Access time to the system is relatively long. Underground stations are costly to build and are widely spaced. Such systems are appropriate for long trips where the volume of travel along the corridor warrants the investment.

Service attributes of rail rapid transit systems, while tolerated, are not considered ideal. Use requires time-table dependent waiting or rushing. Entry and exit to and from stations and vehicles may be uncomfortable or impossible for many. Long intervals between runs, especially during off-peak hours and standing in crowded vehicles during peak hours discourages use. Tokyo's railroad and subway net.-work is one of the most extensive and modern in the world. Seventeen railroad companies operate 35 passenger lines with a total length of 832 km (520 miles) in the greater Metropolitan Tokyo region, and seven lines of subway with a total length of 155 km (97 miles). Railroads and subways account for **20.4** million passenger trips each day, or over 59 percent of all passenger trips made within 50 km (23.5 miles) of the city center.

Despite the extensiveness of the network, it lacks the capacity to handle rush hour demands. on almost all the lines during the morning rush hours, trains are overcrowded to **2.5** times normal capacity. Passengers are so tightly squeezed together that injuries are not uncommon. Railroads hire college students as '(pushers') **and** "pullers" to get people on or off the trains.

Efforts to meet the growing demand include such measures as: increasing the length of the trains, combining different suburban railroad lines to and from downtown points, adding additional tracks to existing lines, and improving old and adding new subway lines downtown. Three measures are hampered by the cost of underground construction and by the lack of space for extending station platforms or building new subways.

The high construction and operating costs, the space constraints and undesirable service features of heavy rail rapid transit systems are cited as justification for pursuing an automated guideway transit alternative.

DESIRED AUTOMATED GUIDEWAY TRANSIT CHARACTERISTICS

To overcome the deficiencies cited above, and to improve the supply of public transportation serves, government agencies and private sYstem (developers nave postulated the characteristics desired in an AGT system. These features constitute the goals on which system developments are focused. They are also the basis for planning future installations.

The characteristics summarized below represent a cross-section of the expectation expressed in correspondence from officials in government agencies and industrial firms in Canada, Great Britain, France, West Germany, and Japan.

FLEXIBILITY

Service which is more responsive to the needs of the traveler is envisaged. Departure from limited routes and fixed schedules is the aim. Sufficient capacity to meet peak-hour demands, perhaps with scheduled operations, but on-call service during off-peak hours would best accommodate travel needs. Automation would permit vehicles to be coupled into trains to vary capacity for peak demands without a one-to-one increase in operating personnel, Automation would also enable service to be extended at nights, on holidays and weekends at times when manned service is infeasible. Flexibility in choice of times for departure and arrival should compare favorably with a private automobile. Flexibility also implies the capability to build the system in useful increments so that it can be extended and upgraded without, major changes in the basic technology.

CONVENIENCE

Finer networks of lines with stations spaced closer than rail rapid transit systems would shorten walking distances. off-line stations would permit station spacing from 100 to 350 km (300 to 1,000 ft) without reducing on-line speeds. A network of lines would reduce the need for transfers, reduce the capacity required on individual links and enhance the capability to provide "door-to-door" service.

Such convenience requires exclusive guideways, segregated from other traffic. Guideways must be unobtrusive and with tight turn radii (1 O meters, 33 feet) in order to follow existing street patterns.

Stations should be designed to facilitate transfers. If designed well as part of an urban complex, stations could make transfers an enjoyable part of the trip.

Convenience implies individual usage, or a choice of riding with a roup having the same origin and destination. Direct travel is the aim, But economies and site-specific situations may require transfers or intermediate stops enroute. Convenience also implies minimum overall travel time by providing:

. Short access time by means of convenient stations.
. Short waiting time with frequent service.
. Direct service with few intermediate stops, operating flexibility, and combined services which are responsive to variations in demand.
. Short transfer times where required through frequent service and integration with other modes.
. A high level of service 24 hours a day.

To make travel times comparable to average street traffic, vehicle speeds should be a minimum of 28 km/h (17 mph). To minimize travel times on long trips, top speeds of 60 to 80 km/h (36 to 48 mph) are contemplated.

CAPACITY

AGT systems are needed to fill the gap in capacity between typical bus or tram operations and rail rapid transit services. Intermediate capacities in the range of 2,000, to 30,000 passengers per hour per direction are required. These capacities can be provided by a combination of vehicle sizes and headways. These factors could range from vehicles with 100 passengers and one-minute or more headways, six to 50 passengers and three to 50-seconds headways, down to two or three- passenger cars traveling at headways less than three seconds. The o jectives of greater flexibility and convenience are better satisfied with smaller vehicles and shorter headways. Capacity implies the capability to satisfy peak demands while adapting to daily fluctuations in requirements.

RELIABILITY

Technical components and system integration should achieve a high degree of reliability with operating and maintenance procedures requiring only normal skills. Reliability to the patron means service dependability which would be achieved by adherence to schedules or quick response to on-demand calls. The patron must have confidence in the systems' ability to provide a vehicle that will take him to his destination within reasonable travel times. The system must continue to function, insofar as possible, while observing safety criteria, in the event of breakdowns in the lines, vehicles, automation components, or from congestion in the system.

ENVIRONMENTAL

To minimize the neighborhood impacts, an AGT system should function at the least possible levels of noise and vibration. Direct and indirect air pollution should be minimized. Conflicts with surface movements of vehicles and pedestrians should be avoided in order to improve safety and traffic flow. Land taking should be minimal. Guideways and stations should not intrude or create community barriers. Rather, they should contribute to good urban design by providing relatively low-cost opportunities for physical integration into the architecture of major centers of activity. AGT systems should complement other transport systems and services and should be in accord with related urban functions,

IMPLEMENTATION

Capital investments should be acceptable in terms of the service, direct and indirect benefits expected. Advantage should be taken of small, lighter vehicles and guideways in determining capital costs. Running costs for personnel, energy and operating materials as well as the interest and depreciation on investment over the life of the system should compare favorable with alternative systems. Expectations are that fully automatic operations and lower maintenance costs will make AGT systems more economically attractive than comparable investments in conventional systems.

OTHER

The desired characteristics described above are expected to be achieved with a comfortable ride and no compromise in safety. Furthermore, investment in the infrastructure for an AGT system warmths consideration of its use for goods movement in appropriate settings.

PERCEIVED ADVANTAGES AND OPPORTUNITIES

Achievement of the characteristics described above offer many opportunities for alternative solutions to urban problems. Public transportation is recognized for its key role in urban development and the opportunities it holds for arresting some of the problems created by private automobiles. AGT systems are perceived as advantageous by enhancing the role of public transportation in improving the environment, reducing air pollution, easing traffic congestion, and filling a gap in the demand for urban mobility with a more rational use of petroleum fuels.

Sponsors perceived that AGT sy:stems allow additional intermediate transit capacity to be introduced into existing cities with a minimum of disruption. Smaller ph~'sical dimensions present opportunities for lower capital costs and easier insertion into urban space. Line capacities could be increased in a small cross-sectional area in congested urban situations. Segregated tracks, above ground or tunneled, should be less expensive than rail rapid transit tracks.

Automation is perceived as an opportunity to provide more frequentl, responsive service. Achieving full automation introduces the opportunity to curb rising costs entirely controlled by escalating labor costs. By the same token, AGT offers a public transport solution which avoids the necessity for working large numbers of people at unsocial hours. Dependability' is enhanced by eliminating potential labor conflicts. Thus, there is an opportunity to provide public transport in an

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acceptable form, under particular circumstances, at all hours of the dav or night. In such a situation, traffic restraints on private automobiles could become more accetable.

AGT is expected to achieve t e same transport effectiveness at 50 percent of the cost of highway technology. At intermediate capacities, AGT systems have the opportunity to provide transit service in average cities where demands do not warrant heavy rail rapid transit installations. In this regard, AGT is perceived as an agent for renewin interest in public mass transportation.

P lanning for AGT system installations in Europe and Japan is primarily concerned with the following opportunities:

- In heavily traveled corridors, AGT systems would augment existing modes—subways, streetcars, buses—to relieve the ressures and improve services.
- Fn less dense areas, AGT networks would be complemented by bus service.
- In new towns and limited small areas. AGT svstems would provide general service and feeders to ‘and from subway and railroad stations.

Transportation technology, represented by the new AGT systems can be active or passive, it can be used or not. Only if developed and deployed will there be an opportunity to assess the usefulness of these concepts in overcoming the deficiencies in present transportation systems and achieving the expected advantages.

Chapter 3: Status of Foreign Systems

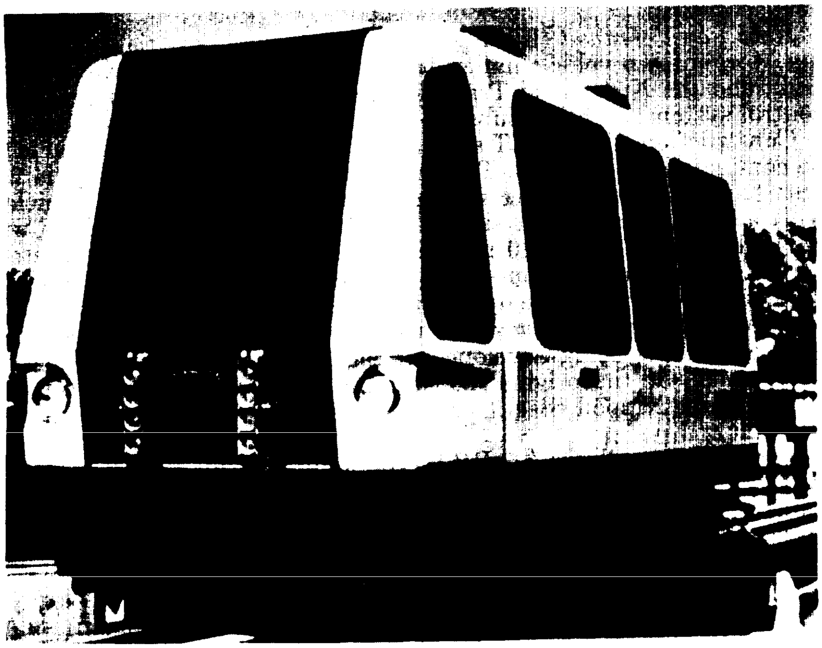
Foreign development of AGT systems commenced later than U.S. development. This lag, a more deliberate planning pace and the smaller economic base available in other countries, have resulted in fewer foreign installations. This chapter presents the status of implementing AGT systems. First, the systems in operation are described, then those under construction. Planning for one system progressed to the point that construction bids were invited, but never awarded. Finally, the status of planned installations is discussed. A more detailed technical discussion of the systems is provided in Chapter 4. Enough description is included here to depict the complexity of the installations.

OPERATIONAL SYSTEMS

Only two operational systems of any significance have been installed—one in Japan and one in France.

YATSU AMUSEMENT PARK, CHIBA PREFECTURE, JAPAN

This installation is a prototype for the system described as the "Vehicle of a New Age" (VONA). A single loop, 400m (1312 ft.) long, with two, 30-passenger, vehicles and one terminal station platform comprise the installation. The vehicles operate automatically, on two-minute headways, without an attendant on the vehicle. Vehicles are designed to travel at a maximum speed of 60 km/hr (36 mph). They do not stop at the station but slow down to 2 km/hr (1.2 mph). The outer ring of the station datform rotates at 2 km/hr to effect loading and unloading.



VONA

The VONA system was developed by Mitsui Trading Company and Nippon Sharo Seizo Kaisha, Ltd. The installation at Yatsu was purchased by the Keisei Electric Company, Ltd. in 1973. No other reformation is available on costs or operations.

PARIS, FRANCE

A prototype installation of a VEC system has been in operation since June, 1974. The installation, 300 meters long, connects a large Paris department store, F. N.A.C., to its remote parking garage in the Montparnasse area. Technical problems have temporarily halted operations.

The system uses two-p assenger vehicles with seats facing outboard. Vehicles normally travel at 1o–2o mph on steel wheels supported by tubular rails. A conveyor belt, propelled by linear induction motors, drives the vehicles. In stations, the vehicles are slowed to about 1 ft/sec or stopped for loading and unloading.

SYSTEMS UNDER CONSTRUCTION

Five AGT systems are under construction—two in Okinawa, one in Nagoya, Ja an, one in Kita-Kyushu, Japan, and one in Toronto, Canada. The Canadian installation has experienced a set-back which is discussed below.

OKINAWA

Two AGT systems are under construction as part of the International Ocean exposition to be held in Okinawa starting in July, 1975. One is a GRT system, as defined elsewhere in this study. The other combines the features of a GRT and a personal dual-mode vehicle system.

Kobe *Rapid Transit* (KRT).—This system uses essential the Boeing Morgantown vehicle under licensing agreements with ~obe Steel, Ltd., and the Nisho Iwai Trading Company. Boeing is su~pl ing the control system; all other subsystems are being fabricated mi apan.

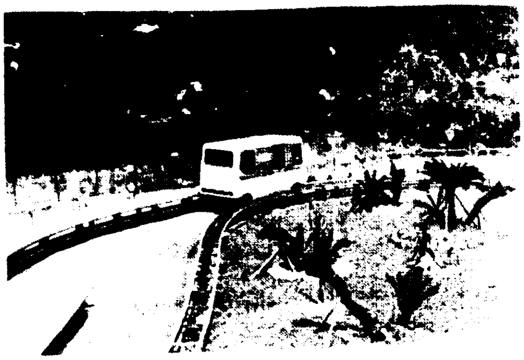
Construction of the KRT system began in November 1974 and is to be complete by July 1975. The overall length of the guideway is 2.8 km (1.75 miles) with three stations. The system will use 16 vehicles, with a capacity for ei ht sitting and 13 standing. The vehicles will travel at top speeds of 30 mph at 15 second headways. The system will include three stations—two on-line terminals and one off-line station. Switching will be demonstrated at the off-line station.

Duul-Mode Vehicle System.—This system, also called CVS, is based on the conce ts being developed at the MITI test track at Higashimurayama. ?)f the original consortium only Mitsubishi Heavy Industmes and Nippon Steel Corporation are Involved in the Okinawa installation.

The system will use 15 PRT-type vehicles and three dual-mode vehicles. The latter will be capable of automated operation on the guideway and manual operation when driven off the guideway. The guideway length is about 1.2 miles with a figure-of-eight configuration at one end. Vehicle speeds will average 20 km/hr (12 mph) at headways of about 13 seconds. Operations will be scheduled rather than ondemand. Five off-line stations will be included in the facilities. As with CVS, the Okinawa vehicles will seat four persons. Other features are quite different: the control system has been simplified to a single computer, the guideway and station designs are less complex, speeds and headways are slower.

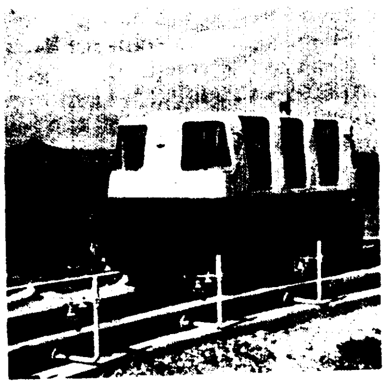
INTERNATIONAL OCEAN EXPOSITION OKINAWA

Kobe Rapid Transit (KRT)
Built by Kobe Steel, Ltd.
in cooperation with
Boeing Aerospace Co.



CVS Dual-mode Vehicle
Is Driven Manually
on the Road . . .

. . . or Controlled
Automatically on the Guideway



KOMAKI, NAGOYA PREFECTURE, JAPAN

In 1974 construction started on a GRT system connecting a newly developed residential town to a neighboring interurban railway station. This system will be 7.7 km (4.6 miles) long and is expected to cost $44.6-million. The system is planned to carry 40,500 passengers per day by 1985. Most of the trips are for work and school.

KITA-KYUSHU, JAPAN

This system, also started in 1974, uses a monorail guide beam. The system, 8.8 km (5.3 miles) long, connects the central business district with a suburban residential area. The installation is expected to cost $87-million. It will be in operation in 1978 and is planned to carry 107,000 passengers per day. Most passengers will be workers or students.

GO-URBAN TRANSIT DEMONSTRATION SYSTEM, TORONTO, ONTARIO, CANADA

In May 1973 Krauss-Maffei AG of Munich, Germany, signed a contract with the Ontario Provincial Government for $16-milTion to build an AGT system at the Canadian National Exhibition Park in Toronto, Ontario. The system was to become operational in August 1975 and available for testing and public passenger-carrying throuh September 1975 followed by a one-year proving test program. The installation was planned with a one-way guidewa loop about 2.5 miles long and an additional mile of station tracts and a storage loop. Four off-line stations were planned, though econom measures reduced these to three stations, one on-line and two on-line. The system design called for full automation, with a hierarchical, trile computer, relatively centralized control s stem. Fifteen vehicYes capable of operation singly or in trains of tiree vehicles were to be tested. Vehicle specifications required 12 seated and 8 to 15 standing passengers. Speeds would normally be 45 mph with a maximum operating speed of 50 mph. Headways would be 10 seconds at 30 mph and 15 seconds at 45 mph. For testing, without public passengers, headways of 6 seconds at 30 mph would be used.

The vehicles were to be magnetically levitated and guided, Electromagnets on the vehicles attracted to armature rails on the guideway would suspend the vehicles. Current to the magnets would be regulated to maintain a constant air gap. No seconday suspension was contemplated. Propulsion was to be supplied by a linear induction motor, controlled by an inverter and fed from a 600-volt D.C.power distribution system.

Switching was to be accomplished magnetically from the vehicle. There were to be no moving parts on the track. An on-board mechanical switch arm deployed from the vehicle would serve as a safety back-u .

By November 1974, most of the 482 guideway caissons had been placed. Existing underground utilities had been relocated. Bids received for the guideway and stations were rejected as excessively costly. These facilities were redesigned to make them more spartan. A 1200-meter engineering test track with full-scale switches was completed in Munich. Two rubber-tired vehicles were built to test the automatic command and control system. The third prototype of the magnetically levitated vehicle had undergone static tests preparatory to the start of drive tests.

At this point, technical difficulties appeared. Weight of the three electromagnetic systems (suspension, propulsion and switching) and electronic controls to regulate them exceeded initial estimates. This added weight, and the vehicle dynamics involved, required heavier, and more costly, guideway beams than had been originally designed. A technical evaluation by the Ontario Urban Transportation Development Corporation (UTDC) found that these problems could be corrected with more time and at additional cost.

From a review of this situation, the German Ministry of Research and Technology concluded that magnetic levitation for transport vehicles was more suitable for high-speed, high-passenger capacity systems. The component weights, electronic complexity and costs could be economically distributed on systems with potentially higher productivity than the small urban vehicles proposed for Toronto.

This review resulted in a decision on 14 November 1974 by the Ministry to withdraw further financial support from the Krauss-kfaffei urban system program. This decision had several consequences.

- Without Ministry financial support Krauss-Maffei was unable to uphold its contract with Ontario. By mutual agreement the contract to complete the Transit Demonstration System has been terminated.
- The Ministry has consolidated magnetic levitation development in a new program to develop a 400 km/hr (240 mph) train. This program reaffirrns confidence in the performance, environmental advantages, and freedom from obsolescence afforded by mag-lev technology. The program combines the talents of both Krauss-Maffei and Messerschmitt-Bolkow-Blohm in a new consortium funded by the Ministry.
- Krauss-Maffei is continuing the development of an automated ~rban transportation vehicle system. This development will retain the best features of the linear induction propulsion system and control system previously developed.

UTDC is now seeking other vehicle and system suppliers to complete the Transit Demonstration System. Available choices are under consideration and a decision is expected to be made in time for a revised system to be in operation for the 1977 Canadian National Exposition. Under terms of the licensing arrangements with Krauss-Maffei, UTDC will retain the right to use Krauss-31affei technology, to use the test facilities, and to exchange engineering information on system developments.

SYSTEMS PLANNED TO THE BID STAGE

In 1972 French officials awarded four $100,000 study contracts for an SLT s~-stein to be constructed in conjunction with the new Charles de Gaulle Airport near Paris. The four participants were Jeurnont Schneider (with Westinghouse), MATRA, Regie Renault and the LTV Aerospace Corporation in conjunction with COMSIP Enterprises. The studies were to cover proposals to build a 3.6 km, two-direction, loop from Aerogard No. 1 and the central unit; designs for a second 2.8 km loop from the central unit to Air France at Aerogard No. 2; and Plans for a future extension 4.4 km long to serve other airport faciltiies.

Bids were requested in April 1974 from three firms: LTV/COMSIP, based on AIRTRANS; MTE, a joint venture with Schneider and Creusot Loire, an industrial and ‘railroad heavy equipment manufacturer; and Engins MATRA, using the ARAMIS system. In June, 1974 it was decided to delay the project for several years; no contract awards were made.

SYSTEMS APPLICATION PLANNING

A summary of the status of planned installations is given below:

ENGLAND

Sheffield

Under a study sponsored by the Transport and Road Research Laboratory (TRRL), preliminary design of a GRT system (Minitram) has been completed for Sheffield. Sheffield is in Yorkshire, in the heart of England's industrial area, about 380 km north of London. The population is 570,000 with nearly one million persons in the metropolitan area.

The planning for Sheffield has envisioned use of system concepts advanced by Hawker-Siddeley Dynamics, Ltd. (HSD) or the EASAMS Ltd. (a GEC subsidiary). Both concepts have been under feasibility study financed by the Department of the Environment. The Department has also funded British Rail to investigate magnetic levitation for the Minitram route in Sheffield.

The guideway route starts with a turning loop at the British Rail station and follows the axis of the shopping spine. The route serves bus stations, automobile parking lots, commercial areas, the Town Hall and a pedestrian shopping center. The other terminal serves a redevelopment area. The proposed GRT route makes additional pedestrian shopping areas possible that could not be served as well with existing modes of transport.

A schematic drawing of the route is shown in Figure 1 on the next page.

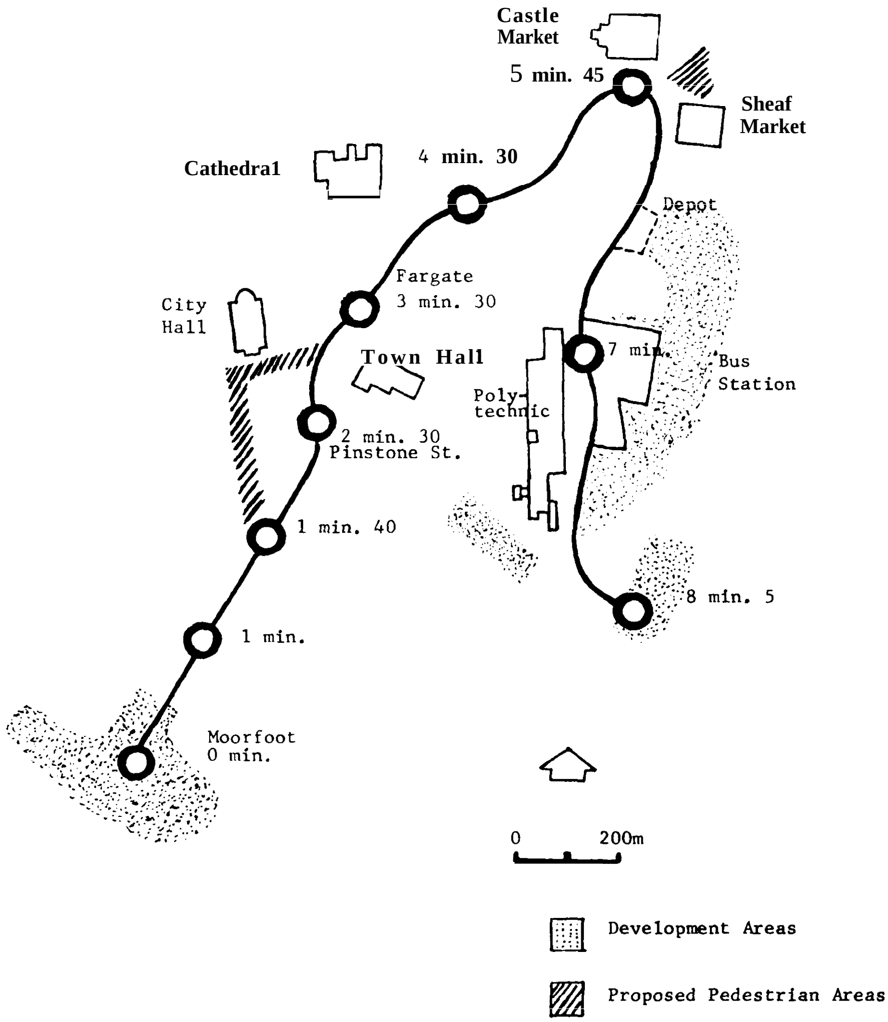


Figure 1.—Route Map—MINTRAM in Sheffield

Planning and preliminary engineering and operations studies were completed in 1974 by Robert Matthew Johnson-Marshall and Partners. The following summarizes the planning for Sheffield:

Guideway	2.4 km of double track. 5.0 km total length with loops. Elevated clearance: 5.1 m at traffic cros-simzs. 3.5 m elsewhere.
Stations	9 s~ations with average spacings of 300 m. 1 or 2 off line. Dwell time: 15 sec.
Vehicles	25 with 6 seated, 6 to 18 standing.
Speed	15–20 km/hr terminal to terminal. 60 km/hr cruise speed.
Headways	Peak hour: 30 sec. Off peak: 90–120 sec.
Operations	Single vehicles off peak: 180 seats/hour. 3-car trains, peak hour 5,400 passengers per hour.

On May 22, 1975 the Minister for Transport advised leaders of the Sheffield Metropolitan District Council, and the South Yorkshire County Council, that he would not proceed with the proposal for a public demonstration in Sheffield of the Minitram automated public transit system. The two main reasons given for the decision were the public expenditures required and the need for more development work before the system could enter public use. The decision is a final one for a public demonstration at this particular site. This avoids leaving any uncertainty in Sheffield which might affect other proposals for the development of the city. Research plans are being revised and an experimental test track program for Minitram is being reconsidered.

Brighton

An SLT system has been proposed for Brighton, East Sussex. Brighton is a seaside resort, **50** km (30 miles) from London, with a population of 400,000. The system runs a distance of 2.8 km (1.75 miles) between Aquarium and Black Rock along the seafront. The SLT system would replace the Volk Railway which is an existing narrow gauge railroad built in 1883. This railroad is now considered antiquated with limited capacity and poor service amenities.

The SLTProject is sponsored by the Brighton Corporation, Proposals have been received from Otis International for a small vehicle system, and from Sussex University for a magnetically levitated system. Since most government funds available for AGT development are focused on the Minitram project and a possible demonstration elsewhere, the Brighton proposal has a highly doubtful near-term future.

Summary.—Princi al government planning efforts are focussed on the project in Sheffield. The government has sponsored a competition between two potential suppliers—EASAMS Ltd. and Hawker Siddeley Dynamics Ltd.—and is evaluating a magnetically levitated alternative system. Since the risks are considered too great for commercialization at this time, the Department of the Environment is financing 100 percent of the development and planning costs. Cancellation of the reject in Sheffield would likely have a serious effect on the future or AGT development in England.

FRANCE

Initiatives in France for planning AGT systems appear to originate local 'y. The central government has encouraged local innovation with the result that several projects are well along in the planning phase. The projects are focussed on solving urban transportation problems, not merely the application of new technologies in special settings.

Along with the local initiative there is an early marriage between hardware suppliers and local planners. This arrangement, which is quite different from U.S. practices, is claimed to have several advantages:

- Wasteful competition is eliminated at a time in the life of a project when hard decisions are needed.
- Early involvement of a system supplier makes his designs more responsive to public needs, and makes project planning more realistic in terms of the technologies that can be furnished.

- An early commitment to a system supplier reduces anxiety about the market and eases the financial burden in preparing preliminary engineering and cost data.

This arrangement in France is evidenced by the presumption that Societe POMA has a clear field in Grenoble; that Otis/SOCEA will build the system in Nancy; and that MATRA is favored in Line and Nice. These, and other plans under consideration in France, are discussed below.

Grenoble

The city of Grenoble has a population of 340,000, with 420,000 in the region. It is now experiencing one of the most rapid growths of any French city, with a population of 510,0OO expected for the region by 1985. Current public transport needs are met by trolleys (3 lines, 30 vehicles and 25 km of routes), and by buses (15 lines, 100 vehicles and 135 km of routes). Use of public transportation is declining, which the Agence d'Urbanisme de la Region Grenoblois (AURG) attributes to its service characteristics, Buses, for example, average less than 8 km/hr (5 mph) in the city. To reverse this trend AURG has adopted a planning policy which concentrates on:

- Improving the existing trolley and bus systems.
- Creating a completely new system on an exclusive right-of-way.

The system on which planning is based is the POMA 2000. This system was developed in Grenoble by Pomagalski (a ski lift manufacturer) and Creusot Loire. The planned installation for Grenoble envisages three lines requiring passenger, rather than vehicle, transfers between the lines. A total system with 40 km (25 miles) of two-way lines is contemplated. The system would be built in four stages, with an initial 1 km demonstration line.

The demonstration line, which would become part of the 15 km revenue line, would connect the new town of Echirolles to downtown Grenoble. A l-million FFr study has been undertaken for the preliminary design of this line. Results are expected in the spring of 1977. Cars with 15 seated and 15 standees have been considered, but no decision has been made and, hence, no data are available on the number of cars or capacity of the system. Stations would be on line, though a switching capability is being developed for situations where a double track and limited express service is deemed desirable. The system concept is limited to scheduled service, since the operating mode precludes demand responsiveness.

The major planning difficulties center on whether or not parts of the line must be put underground. Societe PO.MA 2000 and AURG originally envisaged an aerial structure throughout. However, the central area of Grenoble, where the three lines would cross, contains clustered old buildings on narrow streets. There are legal questions as to whether an elevated guideway could be permitted to obscure two historic plazas. Many local officials consider that an elevated structure in the central area would be destructive. Thus, there has been considerable pressure on the local planners to place the lines underground in the center area. Underground construction would quadruple the cost of an elevated system.

Construction of the elevated demonstration line has been estimated to cost about $6-million, No decision has been made to proceed with the demonstration sy~stem. Thus, no schedule for planning and constructing the system 1s available.

Nancy

The city of Nancy is growing almost as rapidly as Grenoble. Only 17 percent of CBD trips are made on public transport, and a decline in usage is attributed to increasing affluence in the area. As a result, the narrow city streets are greatly congested; pollution and motor vehicle accidents are considered serious problems. Near term improvements focus on the bus s)'stem, while longer term solutions involve an automated guideway transit system.

(he of the largest manufacturing firms in France is the Saint Gobain-l?ont a' Mousson group, located in Nancy. The group's subsidiary)', SOCEA (an engineering and construction firm), teamed as the prime contractor, with Otis-TTD in 1973. A project plan was submitted to the District Urbain de Nancy in December 1974. This plan is summarized below:

Guideway. -------	23.1 km (13.9 mi) of one-way guideways and sidings. Elevated—13.8 km (8.3 mi). Underground—9.3 km (5.6 mi.)
Stations- -- _ --- _ --	Total—28. Elevated—18. Underground—lO. Dwell Times—15 sec. Initialiy on-line, but with provisions for later conversion to off-line operations.
Vehicles- - _ _ _ --- _ _	Suspension —air cushion. Propulsion—linear induction motor. Capacity—12–16 seated, 20–16 standing, 32 total capacity. Vehicles per train—3 (individual or 2-car trains in off-peak hours). Total number—106 (10 spares). 37—Train Lead Cars. 69—Train Cars (1$'ithout Vehicle Control System).
Speed- --- _ _ -- _ _ --	Maximum—50 km/hr 30 mph). Civil Limits on Curves-40 km/hr (24 mph), 23 km/hr (14 mph) and 18 km/hr (11 mph).
1leadways _ _ _ _ _ ---	West Loop—43 sec. East Loop—90 sec. West Loop Turnback—84 sec. East Loop Turnback—90 sec.
Operations ---- - _. -	Inbound plus outbound service—Initially: 14,300 passenger trips/hr. Growth: 3.9 percent per year for 10 yrs. 19 hr scheduled operations per day.

Several alternative plans have been considered. The favored option at present would start operations with three-car trains in a line-stop mode of operation. Provision would be made for convwsion to off-line operations and individual vehicle operations within the second half of the first decade of operations to accommodate the projected traffic increase. This conversion would substantiate further capital investment. This changeover would be accomplished without interruption of service. The District of Nancy has not formally responded to the proposed plan. As a result of elections held in the fall of 1974, the district is reorganizing with appointment of a new transit director and staff. While there is still interest in the Otis-TTD system, a certain amount of redirection is anticipated. The project, which may take from 4 to 5 years to complete, is expected to be delayed at least a year.

Line

The city of Line has a population of 800,000 and is expected to grow to one million by 1985. It is part of an urban complex of 1,470,000 comprising Lille, Roubaix and Tourcoing. This three-city conurbation embracm 87 separate municipalities.

At present, Line is served by three transportation systems:

- Buses provide some local service throughout the mea.
- The national railways (SNCF) have a terminal station in Line with main line and suburban services to nearby towns in seven directions.
- The Societe Nouvelle L'Electrique Lille' Roubaix-Tourcoing **(ELRT)** operates **23** km of meter-gauge electric tramway, 86 percent of it on reserved track. This tramway links Line with the cities of Roubais and Tourcoing near the Belgian frontier. Although the fleet of 28 cars is over 20 years old, these are being progresively modernized and much of the track has been renewed and upgraded. Commercial speed of the cars at present is 22 km/hr (13 mph).

Transport planning in the region has considered several possibilities:

- Proposals exist for a metro system which would connect Lille with Nord-pas de Calais, Tourcoing and Arras. Other metro lines would serve Ronchin, Lomme, La Madeleine, Roubaix/ Tourcoing and Velleneuve d'Aeq (Lille-Est). A new metro line through the center of Line to the Regional Hospital center would require mini-metro cars to save costs in tunnel construction.
- An automated guideway transit system (1'AL) has also been proposed to connect Lille with the new town, as well as to provide service to the hospital center, Tourcoing and Roubaix.

Engins MATRA, in conjunction with EPALE (the public authority formed to direct. development of the new town) have undertaken planning the VAL system to Lille-Est and the university there.

T'here has been considerable controversy about the system recently, mainly of a political **nature** but to some extent flavored with technical concerns. One of the three remaining streetcar lines in France is in the city of Lille and this has resulted m a huge contrivers}: between the advocates of VAL and those who prefer light rail transit technology?'. The issues are well summarized in an October 1973 article in *Railway* Gazette *International* by Professor Vuchic of the University of Pennsylvania. To resolve the controversy, the city of Lille has requested financial assistance from the government to undertake a two-phase further analysis lasting a total of about 9 months. The government has not yet provided any funding for this study, but the French Chamber of Deputies in late 1974 authorized the government to decide whether to provide more funds. A decision is expected in about **2** to **3** months.

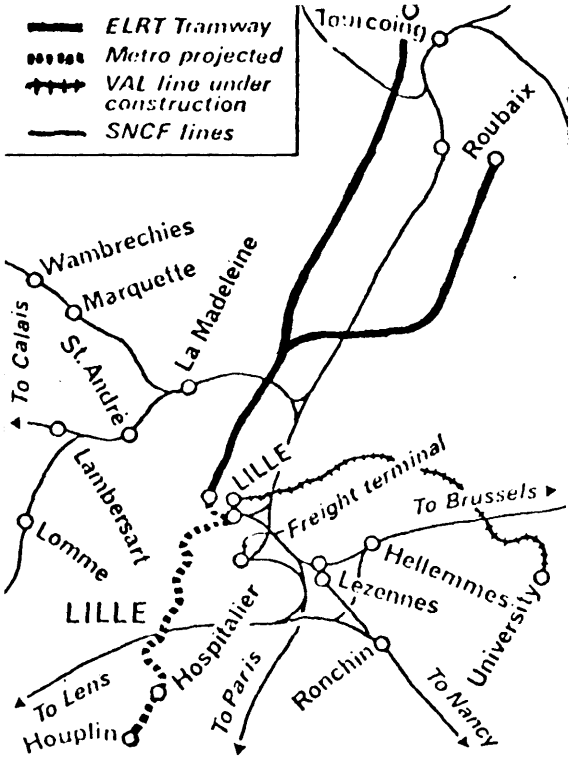


Figure 2.—Route Ma~VAL in Line

The selection of VAL is one of the few examples in France of the use of the American technique of inviting proposals through a request for proposals (RFP). Engins MATRA was the winner of the competition. The Paris metro system (RATP) is a consultant to EPALE for the decision on the system.

Though VAL is an elementary SLT system, use of a fully automated vehicle is seen by the participating agencies m Line as a major innovation and departure from tradition.

Paris

The Regie Autonome des Transports Parisiens (RATP), the regional transport authority for Paris, is involved in three aspects of PRT development and planning.

. RATP is managing, on behalf of the French ~overnment, a develo ment program to establish the reliabihty, safety, costs, tra& management, and ultimate qualification of the ARAMIS PRT system. This program is based on the results of earlier experiments carried out on a l-km test track with 3 vehicles near Orly Airport. This 12-month study began in September 1974 and includes a parallel assessment of bus transit. Two comparisons of the costs and benefits are being made. One compares the performance of both systems in meeting the same total demand. The other optimizes the two systems and com- ares performance for the resulting demand, Preliminary Rndings suggest that the bus service is 2 to 3 times as expensive as ARAMIS.

- A new test track with 3 km of guideway, 3 stations and 10 to 15 six-passen er vehicles is bein planned in the vicinity of Creteil and 6 hoisy-le Roi near $ aris. (Consideration is also being given to the use of 12-passenger vehicles for this demonstration.) Tests will not involve passengers, but will focus on maintainability and automatic test eqmpment. The aim is to have the system certified for urban use in 1977 or 1978.
- Concepts are bein developed for a revenue system to link suburban terminals of rail commuter lines. The eventual plan is to provide a rather complete network linking the commuter lines on the outskirts of Paris in an arc about 70 km in length. An extension of 20 km would be made by 1982 and the remaining connections would be completed by 1990. Since these plans are to provide case studies to guide realistic development of ARAMIS, there are no commitments to their implementation. A demonstration line, comprising a useful increment of a commercial system is contemplated. This line would be 6–10 km long, include 6-8 stations and would involve 200-300 vehicles, Capacity would handle 2000 people per hour in one direction. Building and testing would require 26 months plier to the start of passenger operations.

Nice

With a population of 300,000 no corridor in Nice is ever expected to generate more than 10,000 passengers per hour. Since difficult subterranean conditions exist, the municipal authorities decided to examine an advanced transportation system in lieu of a subway. In 1974 a study was commissioned to consider an ARAMIS PRT system.
The system being studied would be largely elevated, use 4 to 12 passenger vehicles, would be demand activated, and would operate at speeds of about 50 km/hr (30 mph), Although no route plans have been published, a north-south alignment from St. Sylvestre to Massena and an east-west corridor from St. Augustin to the port of ISice are being examined, Long-range plans call for a network of 35-4o km of double tracks, 50–55 stations and approximately 2000 vehicles. The system would carry 8000 peak-hour passengers in one direction, Near term lans, to be completed by the end of 1975, call for an increment 6–10 km long with 10–15 stations. Though this reference line is to be self supporting, no data was available on potential patronage or numbers of vehicles anticipated.

S'unwnary.-France: Planning in France which contemplates AGT technology is focussed on urban transportation problems. Service is planned to complement existing systems, to relieve street traffic or to provicie new service where either marginal or no service exists. The major planning difficulties occur with the problems of inserting a new elevated guidewa~' s~wtem into an older historic community. The costs of tunneling an~' transit system are almost prohibitive. Where serious planning for AGT systems is occurring, there has been an early selection of system hardware. Principal systems being considered me POMA 2000, Otis-TTD, ARAMIS and VAIJ.

SWEDEN

Gothenburg is the second largest city in Sweden, with a population of 458,000 and 690,000 in the region. The total regional population is expected to go to about 850,000 by 1985. As headquarters for Volvo, it is one of Sweden's most important industrial cities.

At present Gothenburg has 10 tram lines 96 km in length (60 miles) with 268 trams in service. Though tram and bus ridership have shown a steady clecline over the past 20 years, Gothenburg is planning some extensions to the existing tramlines. One factor contributing to the decline of ridershi is the high standard of living which is expected to increase automobiYe ownership from 0.33 per capita to 0.55 by 1985.

In 1970a study of a large PRT system was i~itiated b,? the Goteborg Sparvager (municipal transport operators) under the direction of Mr. Sixten Camp. This study concluded by recommending a PRT system using five-passenger vehicles and having 250 km (153 miles) of double track and 360 stations. The stations were intencled to be within 800-1000 meters from homes in low density areas and 500 meters in high density areas. This system would require 18,000 vehicles. The report recommended that a test track be constructed for demonstration purposes, and that the entire network be built in stages over a 20–25 ~"ear period. The table below suggests the staging plan and related change in control technology toward shorter headways for the initial increment of the total network.

Table I.–Staged plan for Gothenburg, Sweden, PRT system

Part	D:;abJ: miles	Stations	Vehicles	I n operation	Cost mill ion crowns	Headway (seconds)
1 . . .	3	6	100	1976		8,0
2.			800	1980	l %	4.0
3. ...., ... ,,.	: :	; :	1,100	1985	150	2.0
4, ...	3	9		1985	200	1,5

The network proposed would be expected to attract 38 percent of the trips made in the year 2000, compared with 13 percent for the conventional bus and train systems.

In 1972 a second study was made, the Gothenburg Public Transport Study, and all alternatives including PRT were reexamined. This study concluded that all of the modes were feasible, and that the PRT system with small vehicles would be preferred. It recommended against use of the subway s~"stem originall~. planned for C~othenburg. However it also concluded that there were technical and economic uncertainties with the new sj~stem, and that satkfactorj" public transport could be provided for the next few years by conventional means.

The recommendations from the study were:

- . Improve the existing system.
- . Reconsider the use of an advanced system in 5 years (before 1980) .
- . Reserve space for an advanced system with a fairly dense network of the PRT type,

WEST GERNfANY

Planning for AGT systems in West German?-, as in France, depends on an early close association of hardware supplier and local agencies, Three systems under development and their" planning sites include:

Cabinentaxi: DEMag and MBB (Messerschmitt-Bolkow-Blohm GmbH)—Hagen, Westphalia.
Trasurban: Krauss-Maffei-Heidelberg.
H-Bahn: Duwag and Siemens—Erlangen.

The status of each of these planning endeavors is summarized below:

Hagen, Westphalia

In late 1971 the Hagener Strassenbahn AG (street railway system) contracted with the DEhlag-MBB consortium to stud)- the application of a PRT s.~-stem in the greater Hagen area. This area includes peripheral cities of Wetter, Gebelsberg, Herdecke and Berchum Hohenlirnburg, Population in the area is expected to reach 400,000 b~' the ~'ear 2000. These studies were completed in 1972 and have been published in several reports.

While the analysis for Hagen was extensive, some U.S. visitors to Hagener Strassenbahn contend that the effort was no more than a plan to help define operational characteristics for the Cabinentaxi s~stem.

The network for Hagen has been 1aid out in stages. The first stage includes 33 km (20 miles) of guidewa~' and 42 stations. Subsequent stages bring the total s)-stem to 138 km (86 miles) of aerial track and 182 stations.

Traffic projections for the year 2000 suggest a total of 572,000 passenger trips per day (24 hours) with 158,000 for business trips and 414,000 for occasional trips. The volume of morning peak hour travel was estimated at 56,000. With the closely meshed network, station loading was estimated as averaging about 170 alighting and entering passengers per peak hour over both directions of travel. Only in exceptional instances would station loading exceed 300 passengers per peak hour.

At a pessimistic occllpanc~" value of one passenger per car, for about 96 percent of the line length, a capacity less than 4,000 cars per hour is required. The following table summarizes the number of cars with a three-seat capacit~- required for various degrees of occupancy.

Table 2.—Occupancy rates projected for Hagen-area PRT system

Occupancy.						
Occupied runs..	34,3;:	28,5;;	24,5;:	21,4::	19,0k:	17,1%
Empty runs.	18,000	15,000	12,860	11,250	10,000	9,000
Number of cars.	8,900	7,400	6,400	5,600	5,000	4,500

The computation is based on a peak hour demand of 34,300 passengers on a mean distance for one useful run of 6.07 km. The modal-split models for predicting patronage used total trip time as the principal parameter.[5] These analyses predicted use by Cabinentaxi of 60 percent of the overall peak hour travel, 60 percent of the business trips, 40 percent of the occasional trips. While 50 percent of the overall daily trip average was projected for Cabinentaxi, only 20 percent of the overall average for short-distance travel was forecast for the conventional bus and tram systems. 1

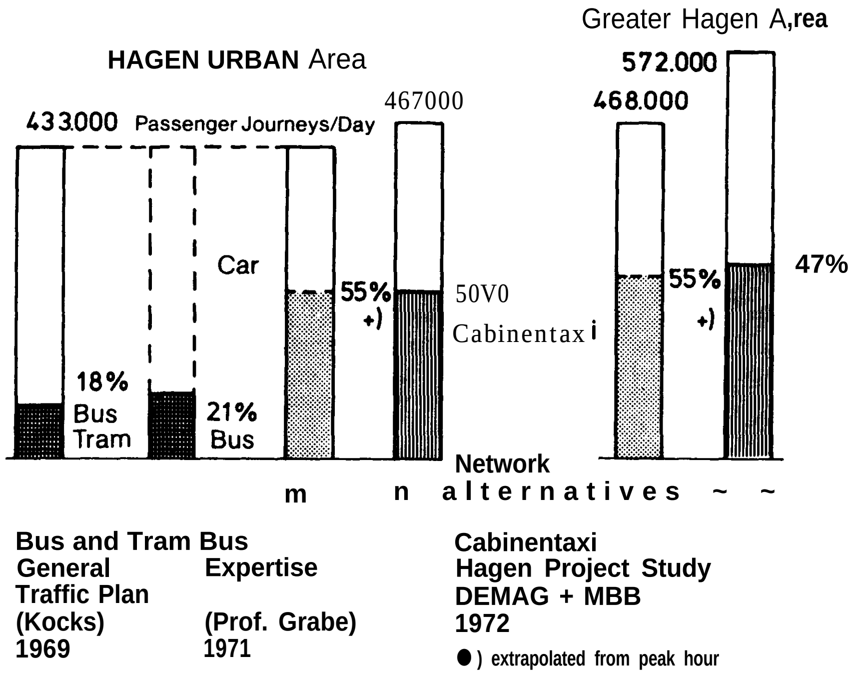


Figure 3.—Comparison of Forecasts for the Year 2000
Source: DEMag-MBB, Hagen, West Germany.

The Cabinentaxi, developed as a PRT system, would operate at one-second headways, traveling at speeds of 36 km/hr (22 mph). These headways and speeds have been demonstrated at the Hagen test facility.

A reduction in the FY 1975 budget for the Ministry of Transport eliminated a proposed urban demonstration of Cabinentaxi in Hagen.

Comparative Analysis of Hagen

An independent analysis of transit network plans for Ha en, West Germany, has been made by Dr. Guert Hu kes, Vice President, Center for Transportation Planning, Utrecht,' The Netherlands. This analysis compared Cabinentaxi, Transurban, an upgraded bus/tram system using reserved rights of way, and an actual bus~tram system having no exclusive right-of-way. The study used basic data derived from the original Hagen study and from the system suppliers, but modified as deemed necessary for purposes of comparison. Costs were prepared for the years 1975–2000, using 1972 guilders which have been converted below at the rate of $0.30/guilder, exclusive of inflation. The study assumed a 4 percent yearly growth for wages and 6 percent for energy. The following table summarizes the results of this analysis.

Results of comparative analysis

	Cabinen-taxi	Trans. urban	Bus/tram right of way	Bus tram no rfght of way
System date:				
Inhabitants	400,000	400,000	400,000	300,000
Network (kilometers)/(miles)	I~8~~&J	83fW&	1 19/;;;	145{::
Vehicles				
Commercial sDeed (kilometers Der hour) /(miles per hour)	304&	33/19	25/15	15/9
Person net		350	978	790
Passengers/year (millions)	60	60	60	30
Passenger kilometers/year (mile lions)	300/180	300/180	300/180	120/72
Cost (million dollars):				
Investment in infrastructure	249	206	120	0
Investment per vehicle (dollars)	4,500	60,000		
1975 cost 1		21	16.2	9.6
2000 cost 1	3 %	34.8	; . ;	22
1975-2000 cost totaled 1	712	654		354
Disbenefits per year: ~				
Energy used (billion kilo calories)	279	240	75	119
Land use (hectares)/(acres)	35/;;	42/1~()	114/2;$	146/361
Noise index (db (A))				100
Air pollution (tonnes)/(tons)	559/616	477/;2;	485/;3;	1,643/1,811
Safety (fatalities)	0.4		0	8,5
Visual intrusion (kilometers/miles viaduct)	69/41	83/5;	50/30	0
Criminality (index)	3		1	1
Benefits per year:				
Travel time won (million hours)	3.35	3,85	-0.25	
Number of iobs	581	549	1,230	1,28:

1 Costs include operations plus 50 percent of investment in infrastructure; the other 50 percent government grant disregarded.
230,000,000 passenger trips per automobile included.

Under the conditions assumed, this study concluded:

- The capital and operating costs of the automated uideway systems investigated over the 25 year period wouldie higher than the costs of the upgraded bus and tram system;
- The disbenefits of the actual bus/tram system are attributed largely to 30 million trips which would be made by automobiles but which would be diverted to the other three innovative concepts; and
- There are benefits in travel times associated with the automated systems as well as reductions in direct and related labor.

Several factors highlighted by the study warrant consideration:

. The ratio of personnel per vehicle for the Cabinentaxi system is low in comparison with United States experience on AGT systems to date.
. This consideration would delay by several years, at current labor inflation rates, any benefits attributed to the labor reduction on the automated systems.
. Cabinentaxi vehicle costs are considered low, even though based on a volume production run of 6–9,000 vehicles.
. The diversion of 30 million automobile trips to any of the three innovative systems would likely require coercive government action.

Other Plans fol Cabinentaxi

Reports persist of Ianning activity involving Cabinentaxi at other locations in West &ermany. The following summarizes the best current information available:

Perlach: A system would serve a surburban community of 80,000 with 30,000 jobs.

Freiburg: A suburban community would be linked to the city center as the first increment of a potential overall network.

Ziegenhain: The hospital, near Kassel, would be equipped with a special version of Cabinentaxi to transport patients, hospital staff, food, supplies and other materials between the different buildings of the medical center. Plans call for the system to be in operation during 1977.

Hamburg and Marl: Applications have been made for a reference installation. Studies would be initiated in 1975. After completion, and if a project is approved, one city would be selected for the installation. Both small and large cabs would be tested for public acceptance and serviceability. Construction would begin m 1977 and the system would be operational in 1979.

Heidelberg

An extensive preliminary design, urban compatibility, patronage and economic feasibility study was done by the Krauss-Maffei consortium in collaboration with the planning authorities of Heidelberg. This study contemplated a Transurban system as developed and tested by Krauss-Maffei at their facilities in Munich. The system involved 3.6 km (2.2 miles) of guideway and 10 stations f~r the central part of the city. Consideration was given to placing the system underground to preselve the historic bmldings in the city center. lt was expected that a small vehicle system could be tunneled at less cost and with less danger to building foundations. Withdrawal of funding support by the Ministry of Research and Technology for Transurban development has not cancelled further planning in Heidelberg. The city is evaluating other bottom-supported GRT systems that could meet planned requirements. Krauss-Maffei is continuing with the development of a GRT system but without magnetic levitation for vehicle suspension, and hopes to team with another supplier.

Erlangen

As the headquarters for Siemens, Erlangen is a natural choice for simulating deployment of the H-Bahn system. A fine-grained network has been planned, with all stations within walking distance. The simulation uses a 45 km network, 60 off-line stations and 260 vehicles. The vehicles seat 8, on two, four-abreast seats facing each other. There is space for an additional 8 standees in the middle. Vehicle speed is planned at 36 km/hr (22 mph) at 8 second headways. Thus, vehicle flow rates are 450 per hour or 3600 seats per hour. Dwell times for a three-berth station are 20 seconds. hTo additional information on the status of plans for deployment of H-Bahn is available.

JAPAN

There is considerable activity throughout Japan concerned with planning the deployment of AGT systems. There is evidence of some intense competition between cities to be the first to install a new system in ,Japan. In addition to the (NS development, eight system suppliers are vying for the market. Two significant planning efforts for deployments in Tokyo, as well as those planned in other parts of Japan, are discussed below.

Ikebukuro, Tokyo

The most ambitious lans for deployment of CVS involve the northwestern part of To[yo, Ikebukuro. These plans would connect central Tokyo with Ikebukuro by means of 8.5 km (5.3 miles) of guideway. The four-lane track would be all elevated with two lanes northbound and two southbound. The system would be designed to carry both passengers and goods. However, the 36 to 50 stations along the route would be designated to handle either people or cargo, but not both. Stations would be simple in design with a single channel, off-line ~latform, space for a few vehicle berths, fare collection gates, destination selection equipment and a small shelter. Vehicles would operate at one-second headways during peak hours. Since land is extremely expensive in Tokyo, every effort has been made to minimize the space requirements. The study is being financed largely by private industrial groups with very few data released. Representatives of .Mitsubishi report that planning was about 90 percent complete at the end of 1974. The plan is expected to be presented to the Ministry of Construction early in 1975. If approved, it would be submitted to the Ministry of Finance and then to the Diet for appropriations, hopefully during 1975.

Tsukiji, Tokyo

The Tsukiji District of Tokyo is in the eastern part of the city near Tokyo Bay on land reclaimed from the sea. Tsukiji is growing rapidly, and would be an attractive commerical area, if it were served adequately with a transit system.

Funding was approved in 1974 in the amount of $1.7 million for preparation of plans to be submitted to the .Ministry of Construction in mid-1975. Unlike plans for Ikebukuro, the system for Tsukiji would be selected by competition.

Other Planned installations

There are eight industrial firms in Japan either independently developing or marketing their versions of U.S.-licensed automated guideway transit systems. The following is a list of these systems:

Firm	System
Mitsubishi	MAT (Mitsubishi Automated Transit).
Mitiui/Seizo Sharyo	VONA (Vehicle of a New Age).
Kawasaki	KCV (Kawasaki Computer-Controlled Vehicle System).
Hitachi	PARATRANS.
Kobe Steel	KRT[1] (Kobe Rapid Transit).
Niigata Tekko, Sumitomo	NTS[2] (New Transportation System).
Toshiba	Minimonorail.
Nichimen, Fuji Car	Dashaveyor.[3]

1 Adaptation of Boeing/Morgantown.
2 Adaptation of LTV Airtrans.
3 Adaptation of Bendix/Dashaveyor.

These systems exhibit the performance characteristics of SLT or GRT systems. Their technical characteristics vary slightly, but generally conform to specifications for an on-line medium-capacity and medium-speed system. All of the systems listed use rubber tires. All but KRT have track switching systems; all have automatic coupling capabilities. The nominal headway is 90 seconds. These specifications a pear to be tailored for small-scale installations at Osaka and Kobe. Planning for deployments in these cities is discussed below.

Nanko Project, Osaka.—The Nanko Area Project (south Port Area of Osaka) is on reclaimed land in the Osaka harbor, which will have 900 hectares (about 2300 acres) when completed. The permanent population of 40,000 will reside on 110 hectares of land; about 5000 of this population already resides there. Originally intended as primarily industrial, Nanko has been expanded to include a large residential area.

A new GRT system is planned to connect Nanko with the No. 3 subway line terminal. The length of the new system is to be 7.2 km (4.5 males); it would all be aerial, and there would be 9 on-line stations. Extensions within the Nanko area and beyond the No. 3 terminal are planned for the future. The cost of the system is projected at 22 billion yen, or about $70 million ($15 million/mile). A decision on type of system is expected in mid-1975.

Kobe.—A system with many similar features is planned for Kobe, a city with three quarters of a million people. Plans exist for a subway in Kobe (14 km by 1978; 22 km by 1985). The new system, described by representatives of the Traffic and Transportation Bureau of Kobe, would be about 4 km in length, linking Sannomiya station of the Japanese National Railways (JNR) with a "port island" new town. The new town, built on land fill in Kobe arbor, has a projected population of 14,000 people. A completion date of about 4 years was indicated.

Proposed Installations.-One of the companies that is contending for the Osaka and Kobe installations is Mitsui/Seizo Sharyo, M/SS reports that it has submitted the following proposals for installations:

Interurban

Toso New Town in Chiba Prefecture: 3,350 m (10,928 ft) Guideway, 42 Vehicles, 3 Stations, 2.5 min Headway, and 5,640 Passengers/hr Capacity.

Kaihin New Town in Chiba Prefecture: 14,300 m (46,904 ft) Guideway, 178 Vehicles, 8 Stations, 1.5 min Headway, and 20,000 Passengers/hr Capacity.

Tokadai New Town in Aidi Prefecture: 17,500 m (57,400 ft) Guideway, 183 Vehicles, 20 Stations, 1.5 min Headway, and 18,720 Passengers/hr Capacity.

Fujisawa Seibu New Town in Kanagawa Prefecture: 12,000 m (39,360 ft) Guideway, 55 Vehicles, 7 Stations, 2.5 min Headway, and 5,500 Passengers/hr Capacity.

Airport Distributor

Shin Tokyo International Airport in Chiba Prefecture: 600 m (1,968 ft) Guideway, 24 Vehicles, 2 Stations, and 1.5 min Headway.

Cargo Distributor

Grocery Distribution Center in Chiba Prefecture: 7,000 m (22,960 ft) Guideway, 39 Vehicles, and 6 Stations.

No decisions have been made on any of the above proposals.

Summary-Japan.—AGT system planning in Japan is proceeding at a pace commensurate with the status of development. One PRT system, CVS, is being planned for the Ikebukuro District of Tokyo. Since CVS testing will not be completed before the summer of 1978, deployment could not begin earlier. Other installations are being planned for competitive proposals from among eight prospective system suppliers. Several of the planned installations address the transportation problem created by the historic development of many Japanese coastal cities in which the port activities were separated by many miles from the commercial and residential centers of the city. There are numerous other proposals for AGT installations serving new towns, the new Tokyo airport and a food distribution center.

Chapter 4: Description of Foreign Suppliers

Industry support for AGT system development starting in the late 1960's and early 1970's occurred for many reasons. Some companies were already involved in supplying the transportation industry and this new form of transit was a logical extension of their manufacturing and marketing capabilities. The aerospace and military hardware suppliers looked upon AGT development as technically challenging and an opportunity to diversify into a civilian market. The apparent U.S. interest in AGT systems, as evidenced by the N'ew Systems Study, undoubtedly suggested an opportunity for foreign exports. Though energy was not a major concern, problems of the environment, air pollution and automobile congestion provided an incentive for alternative ancl attractive transit s,ystems. The rapidly expanding population and interest in new residential areas—even new towns-invited consideration of complementary new transit systems.

A combination of these factors led many industries to believe that a potential market for such systems was developing that could bring a reasonable return on corporate investments. This belief was reinforced b~ government's willingness to share or totally compensate for the cost of developing this new urbtin transit system.

As a result, hundreds of concepts evolved, many were developed, some have progressed to operational testing and deployment. The following section describes the status of the significant developments which have survived. hTo attempt has been made to exhaust the subject. The purpose is to show that foreign development of AGT systems is seriolw and proceeding on a technically sound basis.

ENGLAND

A PRT network-t 'pe system was first conceived in Great Britain in 1965. Leslie R. dlake of the Brush Electrical Company, a subsidia~~ of Hawker Siddele~", formulated his concepts for such a s~-stem after visiting staRR car and Te]etrans developments in the U.S. Studies of the Auto-Taxi were sponsored by the National Research and Development Corporation (N RDC) in 1967. These studies continued through 1971 under the name of Cabtrack b~- the Transport Research Assessment Group (TRAG), a working group attached to the Joint Ministries of Transport and Technology. A number of components and subsystems of Cabtrack were developed to the stage of full-scale experimental technology at the Ro~'al Aircraft Establishment at Farnborough. During this periocl., a number of crucial aspects of the original concept were altered, but m basic outline, it remained a PRT-t~-]m of s~-stem. The system being developed was to be a 4-seat, automatlcall~ controlled, electrically' propelled vehicle. It was to travel at 35–40 mph on an exclusive guldew~~-. Passengers could travel between stations of their choice without intermediate stops. These features conforni to the Personal Ral)id Transit conce])t as presentl~- defined. An environmental stud}- of Cabtrack undertaken in 1971 endeavored to show the architectural iml)act on the West End of London. The attempt was to assess the visu~il accel)tance of such a s~wtenl in an existing cit~". 'llc Tlrest End was selected because considerable traffic data were available, but the study highlighted the difficulties of adding aerial structures to a well-known, densely developed and cherished section of London. Critical press reports m May, 1971 resulted in a reevaluation of the project.

In 1971 a change in administration of the Department of the Environment and the ensuing reevaluation of Cabtrack resulted in redirection of efforts to a technically less ambitious system. The m'inciDal reasons for dropping Cabtrack were:

- .' Technical goals appeared too ambitious relative to the develom ment funs available and to the benefits to be realized. 'A one-second headway for cars was not regarded as a realistic objective at that time. Better benefit/cost values could be achieved, it was believed, with larger capacity vehicles operating at reater headways.
- Fail-safe features were neither well-enough analyzed nor shown to be feasible at reasonable cost. Risks to passengers had been too readily dismissed in earlier studies,
- The addition of aerial structures within compact, older areas of London (and similar cities) could have serious adverse environmental impacts, far greater than originally envisioned. Tunneling became the only sensible approach, which would be excessively extensive.

The result of the redirection of activity was a decision to study a new concept which became known as "Minitram."

This concept uses a larer vehicle than Cabtrack. It would have mostly on-line stations, afthough the system is being conceived to allow incremental future evolution into a system having PRT attributes, such as: off-line station capabilities, fully automatic control, and some degree of demand responsiveness.

The Department of the Environment, through the Transport and Road Research Laboratory, has competitive feasibility studies with EASAMS Ltd. (a GEC subsidiary) and Hawker Siddeley Dynamics Ltd. Probable characteristics of the eventual system, depending upon final design, are:

Capacity- _. ... ---	12–15 seated, 10–15 standees.
S eed_-----------	30-45 mph.
$ eadways - -------	10 seconds.
Operations---- ----	Individual and 3-car trains.
Grades -_ - _- --- ---	10-percent maximum.

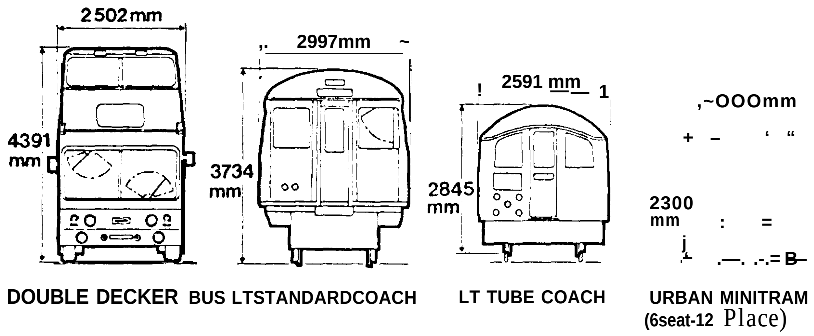


Figure 4.—Cross Section Dimensions of Various Urban Vehicles

Source : Dr. M. H. 1., Waters, *Minitram-The TRRL Programme,* **Transport and Road Research Laboratory, Crowthorne, Berkshire, 1973.**

There are differences in the two system designs:

. The Hawker Siddeley system uses rubber tires on a concrete guideway, A center slot below the running surface provides guidance, power collection and vehicle retention. The vehicle steering mechanism is controlled by guide wheels in the slot. Guideway side walls provide emergency guidance and reduce any noise or splashing.

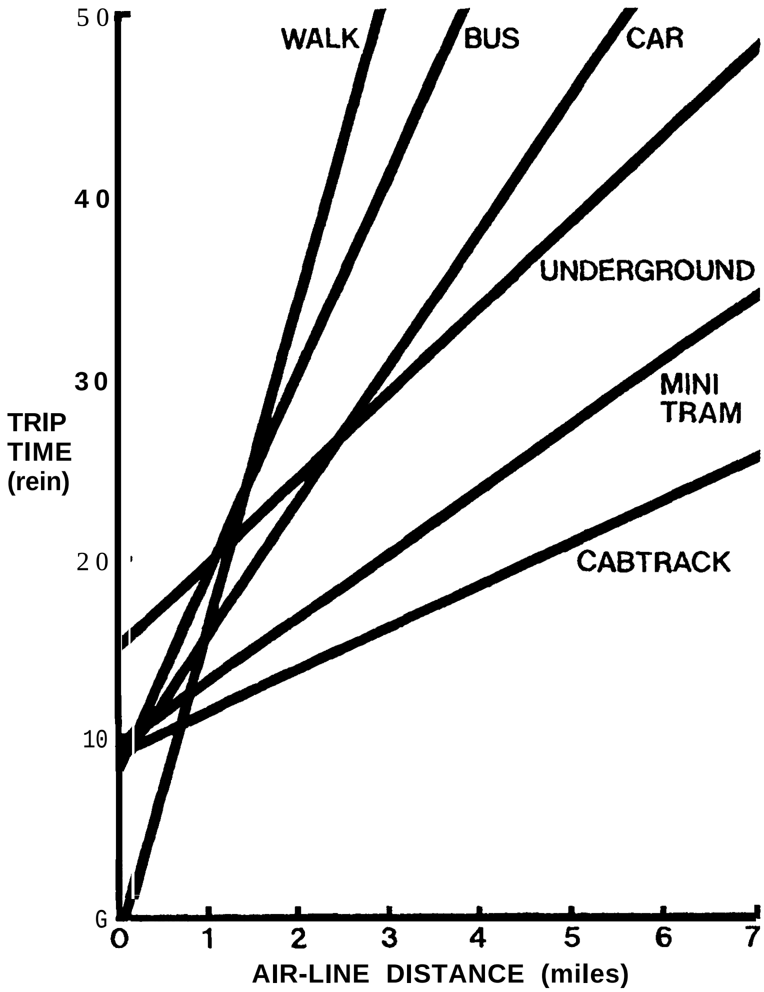


Figure 5.—Performance Curves of Various Urban Vehicles

Source : Dr. J. W. Fitchie, iNew *Tran8port @8tf2m8 for (?it{e8,* **Transport and Road Research Laboratory, Crowthorne, Berkshire ; 1973.**

. **The ESSAMS** system also uses concrete as a supportin structure, but the vehicle uses steel wheels on steel rails. Ti e steel rails are mounted on resilient isolators to reduce noise and vibration. The steel wheels are also fabricated with resilient materials to minimize noise and vibration transmissions. Use of steel wheels and rails eliminates the need for additional uide wheels, but imposes a requirement for steering to avoid fan.ge contact and the resulting noise on tight curves. Concrete side curbs contain the power rails and provide positive vehicle retention.

In addition to the EASAMS and HSD designs, the Department of the Environment is investigating a magnetically levitated alternative. This study is based on the contention that maintenance costs could be lowered through reductions in rotating equipment and less guideway wear. British Rail is doing the magnetic levitation work. Data developed thus far raises more questions than are answered. The possibility of lower reliabilities f?r the magnetic levitation and higher operating costs for linear induction propulsion may offset an}. other advantages.

FRANCE

Three AGT systems are under active development in France. A fourth, VEC, has been installed commercially. Each is discussed below.

A2?AlZ~S'.-The ARAMIS systeIn k being developed by Engins MATRA from patents of Gerard Bardet. This system is the most likely of all French developments to achieve PRT performance. The following is a summary of ARAMIS technical characteristics.

Guideway.. --- _ --	Concrete running surface with lateral guidance curbs.
Stations- ---------	Sized for volume of traffic. Control the adjacent line operations. Load/unloading areas may be superimposed vertically.
Vehicles_ ---------	4–10 seats. Run on 4 pneumatic tires. Guided by 4 rubber wheels. Traction: 2 variable reluctance motors, 1 for each rear wheel.
Speed --- _ ________	50 km/hr (30 mph).
Headway s- -------	Vehicles are electronically coupled 0.3m apart. Spacing: 0.2 seconds between vehicles, 60 seconds between platoons.
Operations ---- _ _ _ -	25 electronically trained vehicles with 10 seats in a platoon could provide a capacity of 15,000 seats. Electronic coupling permits high-speed switching for adding or removing cars. Iligh traffic capacities are possible with off-line stations and high-speed switching.

Development of ARAMIS was started in 1970 with design studies, site feasibility studies in the Paris suburbs and prototype development. A one-km test track with three prototype vehicles has been constructed near Orly Airport. Tests with the prototype vehicles are essentiall~' complete. The cost of the program through this prototype testing phase is about 13.9 million FFr. Total French government assistance since 1970 has been approximately 7.1 million FFr. The second phase of the program started in 1974. The system manager for this phase is the Regie Autonorne des Transports Parisiens (RATP), the regional transport authorit~- for Paris. RATP is funding 70 percent of a 40–50 million FFr program of 30 months duration. This phase will include the following three parts:

I?art I—Design Review, September 1974 to September 1975:

. Analyses of equipment, costs, reliability, safety and traffic management,

. Technical qualification of critical components.

. Redesign of the ARAMIS system incorporating features proven from RATP experience with the Paris Metro and from the design review.

Part II—Qualification Tests, September 1975 to March 1977:

. Construct a *new* test track, 3 km long with 3 stations, crossing switches, underground and elevated sections and 10 to 15 vehicles.

. Conduct qualification tests on the maintainability and automatic diagnostic equipment.

. Public use of the system during these tests is not planned.

Part III—Experimental system, March 1976 to May 1978: 1n parallel with Parts I and 11, case studies will be made of possible ARAMIS installations in the Val de Marne district near Paris. Plans for a possible demonstration installation are discussed in Chapter 3 of this report.

ARAMIS Test Facility, Orly AirporQ Pari% France

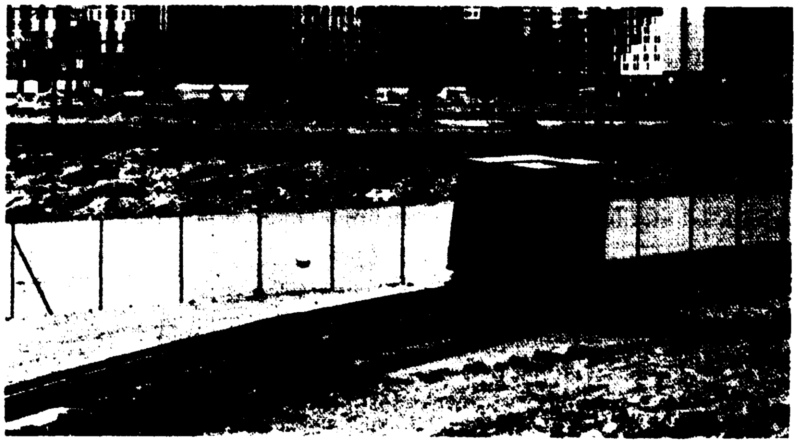
VAL The VAL system is also being developed by Engins MATRA of Velizy, an industrial park near Paris, in conjunction with EPALE, the Public Authority for the Planning of Lille-Est. French government assistance began in 1970. Total expenditures thus far on the system amount to 30 million FFr, of which the government's contribution has totaled about 24 million FFr, the VAL system is fully automated and has the following technical characteristics:

Gujdeway. ------	Concrete running surfaces.
Stations---- -----	On line.
Vehicles_ -- _ -- _ --	Capacity: 36 seated, 17 to 26 standees. Rubber tired.
speed - ---- ------	40 km/hr avg, 30 km/hr max (25-50 mph).
Headways - ------	1 min.
Acceleration- ----	1.3 m/sz (2.8 m/hr/see).
Operations ---- ---	Single- or 2-car trains. Capacity: 2,000-15,000 persons per hour per direction.

Test facilities were constructed in 1972 and consist of a 2 km test track with two switching sections, a station, a central control post and two prototype vehicles. Tests have been underway since 1973. Engins MATRA plans to expand these facilities to provide 8 km of test track and 8 stations in 1975.

VAL Test Vehicle at Line, France

POik2A 2000.-The POMA 2000 was develo ed by a Grenoble firm, Pomagalski (a ski lift manufacturer) and 8reusot Loire Enterprises. A joint venture subsidiary, Societk POMA 2000, has been formed to develop and market the system. POMA 2000 uses a passive vehicle with cable propulsion—a modern version of the San Francisco cable car. However, rubber tires are used foI support and guidance, and the vehicle is automatically latched to the cable and released. In 1971 a prototype vehicle and a test track were constructed at Montmelian. In 1972 two rototy e vehicles and a 565 meter test 100 were constructed at oFmaga Yski facilities in Grenoble. Tests witt the three vehicles since 1972 have resulted in claims that the passive vehicle and simplification of the control system offer major advantages. The ride, at 33 km/hr (20 mph) on the test track is con-



POMA 2000 Test Facility, Grenoble, France

sidered quiet and of high quality. Headways as low as 10 seconds appear to be feasible. This system is fully automated for on-line operations. The vehicles seat 36 with 17 to 27 standees and would operate in married pairs.

The next step in the test program will be to double track the test loop, to add a second station and to build three additional vehicles. These facilities are expected to cost about 8.5 million FFr and will be available early in 1976. Total expenditures thus far on the system are aproximately 4 million FFr. The French government has been assisting with development since 1971. Of the total expenditure, the company is allowed to provide one half, either in cash or in equivalent facihties and services. The General Commission for Scientific and Technical Research provides a loan for the other half. Repayment of this loan with a low interest rate is required only if a return is realized on future commercial sales.

VEC.-The VEC system uses passive vehicles propelled by a conveyor belt. Present vehicles seat two passengers in an open cab, but designs are available for a 4–6 seat enclosed cab with space for six standees. Technical characteristics are summarized below:

Guideway... ----	Concrete with a tubular steel rail for 1 side of the vehicle, the conveyor belt supports the other side.
Stations --- ------	Station lengths determined by traffic. On-line or off-line. May use a moving belt loading platform. Vehicles are slowed to 1 ft/sec or stopped for loading and unloading.
Vehicles -- - -_ -- _ -	Propulsion is pa9sive. For 2-seat vehicle passengers face outboard. For an enclosed vehicle, passengers face fore and aft.
Propulsion ---- ---	In stations, vehicles are moved by slow conveyor belts and accelerated or decelerated by a friction wheel. In line operations, vehicles are moved by a continuous conveyor belt propelled by linear induction motors.
Speed___ ---- -_ _ -	10–20 mph.
Headways -------	Separation is maintained by contact with conveyor belt. Vehicles are allowed to bump at low relative speeds in stations. 2 to 6 second headways are achievable.
Operations -------	Capacities: 1,800 to 21,600 passengers/hour. Shuttles, loops or grids are possible.

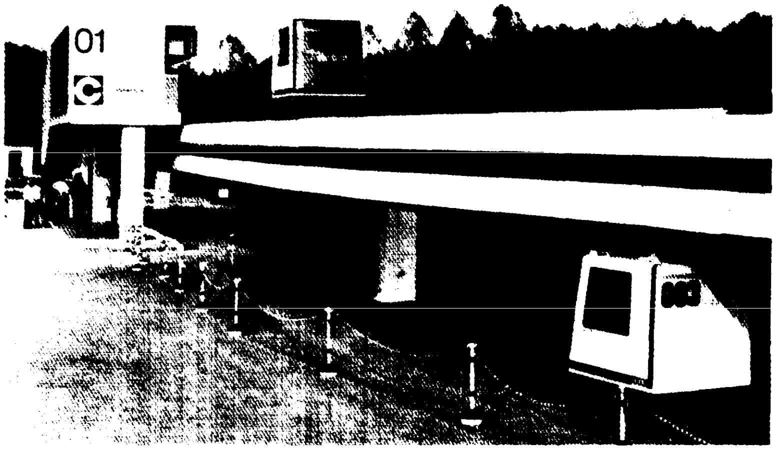
VEC Installation in Montparnasse, Paris, France

The system was developed with French technology by the SAVEC Company. This technology was acquired by Cytec Development, Inc. of Minneapolis, Minn.; a licensing agreement with SAVEC provides for further development with SAVE facilities and for marketing the system in France and elsewhere. Development of the system commenced in 1972. Approximately 1.4 million FFr have been expended to date, of which governmental assistance has totaled about 0.8 million FFr. The French government considers the system ready for commercial applications. It has recently issued a letter of commitment to provide financial assistance in the form of working capital up to about 1 million FFr. This letter was provided through the Ministry of Industry, Commerce and Small Business. In addition, the government is continuing with non-financial support by providing the company a place for demonstrating the system at the planned Transport Expo in 1975.

WEST GERMANY

Development of AGT systems in West Germany began in 1970. The initiative for this development came from private industry. Participation by the Federal industry for Research and Technology commenced in 1972. The development was not ordered, rather an incentive was offered in the form of payments up to 80 percent of the cost. The remaining 20 percent was borne by private industry. Cost sharing was considered advantageous to. the governent in that only those projects would be sponsored which private industry felt could be successful, but which otherwise were too costly, or risky, to be undertaken by industry alone.

Four systems under development in West Germany are discussed below.



Cabinentaxi Test Facility, Hagen, West Germany

Cabinentaxi.— Development of Cabinentaxi was started with design studies in 1970 by DEMag-MBB (Messerschmitt-Bolkow-Blohm). Federal participation commenced in January, 1972. The objectives of this development were to provide an urban transportation system with the following characteristics:

- Small, comfortable vehicles with seats, available at stations and ready for use on demand.
- Origin-to-destination operation with no changes or intermediate stops by virtue of separate stopping tracks at the stations (no obstruction of through traffic).
- Traveling speed of at least 30 km/hr (18 mph).
- Separation of the track from road traffic, most efficiently achieved by elevated guideway structures. The flexibility of the system should permit underground installation, if required.
- Fully automatic operation of the entire system.
- Linear induction motor drive to guarantee low noise levels and no exhaust fumes.

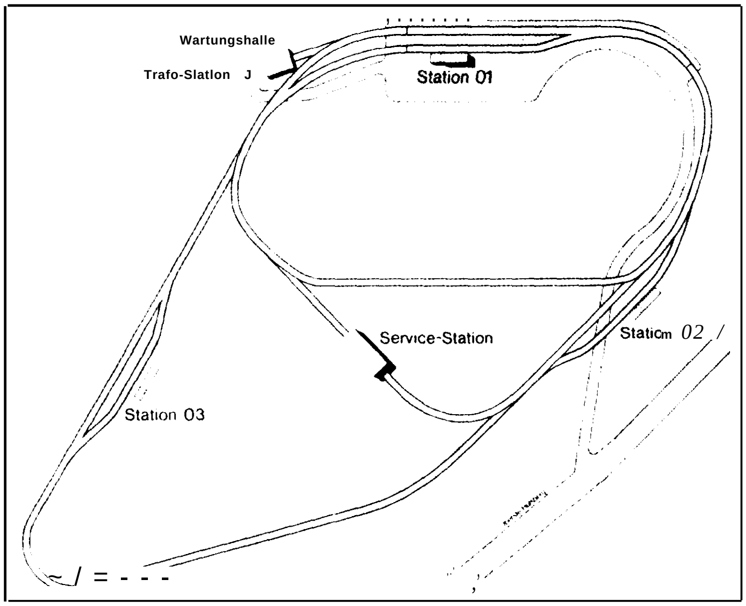


Figure 6.—Cabinentaxi Test Track Configuration, Hagen, West Germany
Source : DEMag-MBB, Hagen, West Germany.

System definition and laboratory experimentation on components commenced in 1972. The control system was developed and tested on a 13m diameter, rotary, test fixture during 16 months, commencing in October, 1972. The first stage of a test faclhty was completed near Hagen in August, 1973, and test operations commenced the next month. Facilities included 150 meters of double guideway (for both supported and suspended vehicles), a merge point, a passenger station and three vehicles. By October, 1974 the track had been extended to a closed 100 with two by-passes, 1136 meters long. Five vehicles, three above an two below the track, have since been undergoing operational tests. In 1975 the track will have two passenger stations, a service building, a check-out position and nine fully automatic vehicles. In October 1975 a 12-seat vehicle is planned to be introduced onto the guideway for testing. In 1976, the test facilities will be completed to form a small operating network with 1.9 km of guideway, three stations and 24 vehicles. Testing will continue through 1977, after which work will begin on a reference installation for public transport in a city. The system is expected to be put into service in 1979.

Technical characteristics for Cabinentaxi are summarized below:

Guideway.. - _ ---	Box girder provides guidance and support for vehicles both under and over the girder.
Stations ----------	Off-line stations spaced 0.3 to 0.8 km apart. Capacity: 1,000 vehicles/hour.
Vehicles_ -- _ _ ----	3 seated, no standees.
Propulsion --- ----	2 double-comb linear electric motors, mounted horizontally inside the box girder.
s eed- --- -_ ---- -	36 km/hr (22 mph).
# eadways - --- --.	0.5–1.0 seconds.
Operations ---- ---	For guideway 20 percent full: 5,000 veh/hr or 15,000 seat/hr. For guideway 100 percent full: 7,200 veh/hr or 21,600 seat/hr.

Headway control is based on three factors: the vehicle's own speed, distance to the preceding vehicle and speed of the preceding vehicle. The headway is a fully asynchronous operation, monotonously increasing with speed. During tests, Cabinentaxi has achieved headways down to 0.5 seconds in the speed range of O–36 km/hr (o–22 mph).[1] Passengers have been carried at l-second headways., but only under manual control. Close-headway operational tests with all vehicles will be performed by the end of 1975.

The vehicle has three independent braking systems: a linear eddy current brake, a hydraulically operated wheel brake and a mechanically operated wheel brake for standstill. Braking is at a constant deceleration. An emergency braking distance of 7 meters (23 feet) has been experimentally demonstrated.

Though Cabinentaxi operates at headways larger than the emergency braking distance, several safety measures have been taken.

- The vehicle structure will resist a brick-wall crash at full speed without loosening essential parts.
- The front side of the passenger cabin is equipped with a crash pad.
- An air bag system is under test—particularly to protect standing children.

Cabinentaxi is the most significant PRT development in West Germany. Tests of a 12-passenger vehicle indicate that GRT a plications are also being considered. The Ministry of Research and Technology has participated in the cost of development since 1 January 1972. Funds allocated by the Ministry through 1975 are estimated at about 37.3-million DM ($13.3-million).

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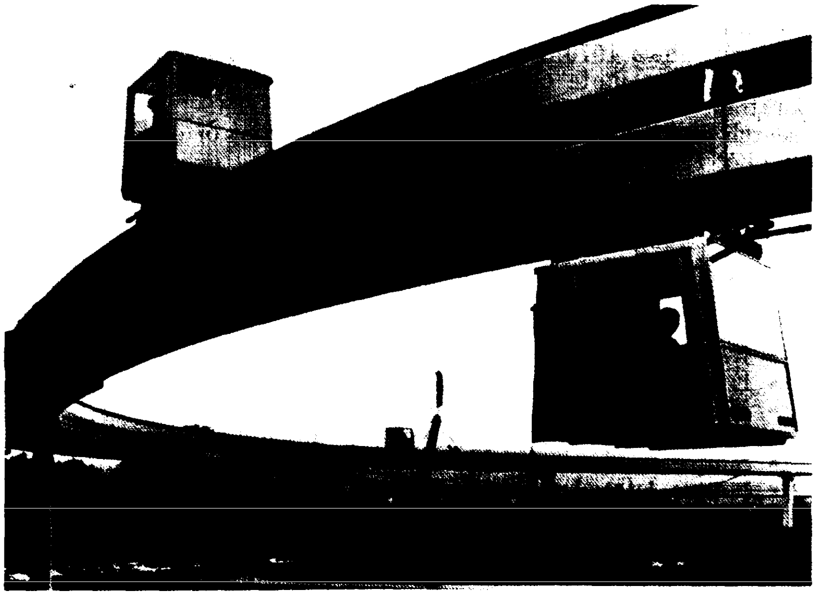
[1] **The 0.5 second headway was attained on the 13m rotary, test fixture in Munich.**



Cabinentaxi: Suspended and Supported Vehicles

Cabinentaxi: Guideway and Supporting Structures

Transurban.—This system has been under development by Krauss-Maffei AG since 1970. Standard Elektrik Lorenz AG has developed the electronic remote control and surveillance system. Design and laboratory testing was sufficiently promising that the Ministry of Research and Technology began sharing the cost of development on 1 October 1971.

Magnetic attraction suspension was demonstrated with a prototype vehicle in 1972. Trade-off studles conducted by Kraus~-Maffei suggested that magnetic attractlon suspension would require less than half the power per unit weight of? repulslon system. Other advantages claimed for the magnetic suspension and guidance system were:

- No contact with the underlying surface (no wear).
- No noise or vibration emission.
- Extremely low drag resistance.
- Minimal vehicle cross section.
- No secondary suspension required (no moving parts).
- Simple track construction with wide techmcal tolerances.
- Simple infrastructure due to better load-distribution and absence of overload problems.

By displacing the armature rails with respect to the magnets for support and guidance, the system was "self centering" and required no additional guidance system. Figure 7 shows the position of linear motors, magnetic suspension and guidance units relative to the reaction and armature rails.

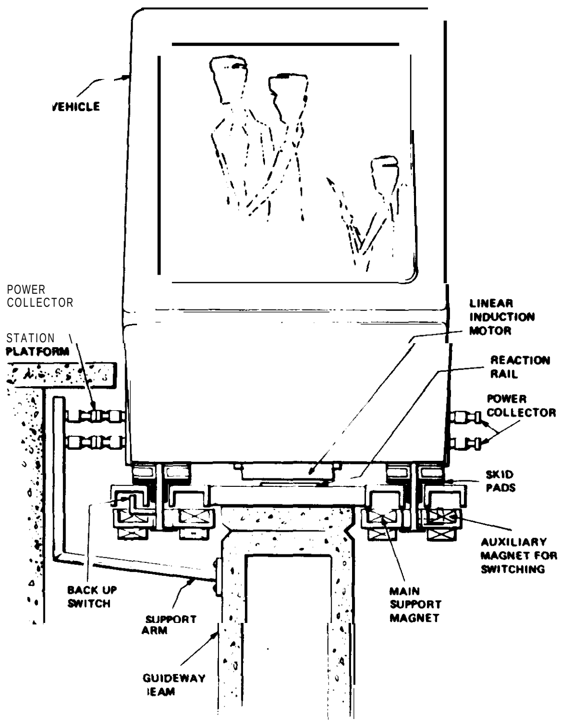


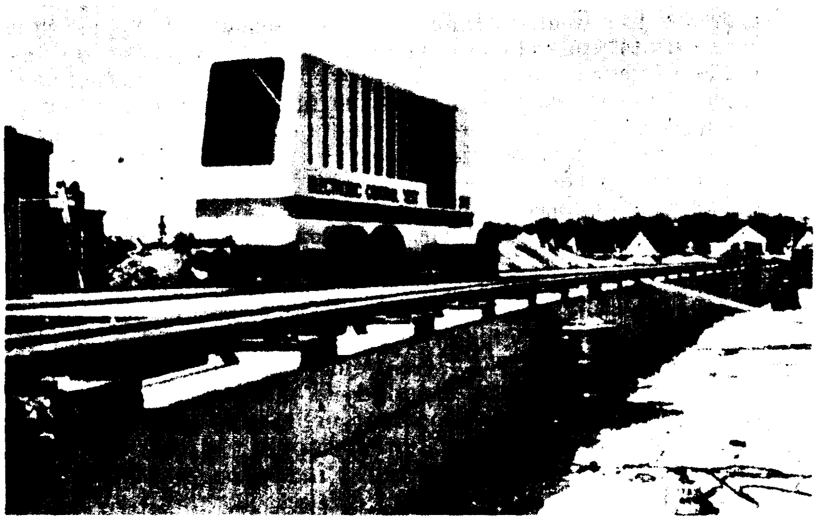
Figure 7.-Cross Section of Transurban Vehicle

Source : "Intermediate Capacity Transit—Ontario's Program," Ontario Ministry of Transportation and Communications ; February, 1974.

Additional characteristics of Transurban are summarized as follows:

Guideway.. -----	Reinforced concrete post and beam construction surmounted by the reaction and armature rails. Radius of curvature at 12mph:30m (98ft). Maximum slope: +8 percent, –15 percent. Clearance for double track: Width:4.40m (14.4 ft). Height: 3.85n~ (12.6 ft). Clearance for tunnels: Width: 5.00m (16.4 ft). Height: 3.85m (12.6 ft).
Stations- ----- _ --	On-line or off-line.
Vehicle ----------	12 seated, 6–8standees.
Propulsion -------	Single-sided linear induction motor. 600 v D.C, 50 kwat50 mph.
Speed ------------	Nominal:45mph. Maximum:50-75mph.
Headways -------	At 48 km/hr (30 mph); 10 seconds. At 72 km/hr (45 mph); 15 seconds.
Operations ______	Vehicles would operate singly or in 5-car trains. Coupling and uncoupling would be automatic. Economic operations were projected at capacities of 100 to 2,000 passengers per hour per direction per vehicle.

A],200-meter (3,636 -foot) test track loop was completed in 1973. This track has been used primarily to test the automatic control system with two rubber-tired vehicles.



Electronic Control Test Car and Track

Another 600-foot test track is available for testing the prototype magnetically levitated vehicle, This track also includes a prototype of the passive switch design.

Prototype Transurban MagLev Vehicle

Visitors to the Krauss-Maffei test facilities who have heard and ridden the prototype vehicle have generally had two observations:

- The system is noisier than expected. Vibration of the reaction plate due to excitation from the linear induction motor produced an objectionable 50-cycle hum. This noise source could be corrected by a heavier plate or by anchoring it more securely to the supports.
- The ride has been described as “hard. ” There is no secondary suspension on the vehicle. Rigid maintenance of an air gap between 10 and 25 mm (0.4-1.0 inches) gives a ride t at emphasizes any imperfections in guideway smoothness.

The German Ministry for Research and Technology allocated 31.7-million DM ($11.3-million) for Transurban development from 1 October 1971 through 1976. The project was terminated on 14 November 1974 for the reasons descrnbed in Chapter 3. Krauss-Maffei remains active in AGT development endeavors and is seeking to establish a joint venture with another supplier so that their earlier work on automated controls and linear induction propulsion can be utilized.

H-Bahn,-This system, designed with the track above the vehicle, is being developed by Siemens and DuWag with financial assistance from the Ministry for Research and Technology.

System design and component tests began m 1973. A 180-meter (590-foot) full scale switch section and tract with a prototype car have been built at the DuWag plant in Dusseldorf. Tests started in October 1974. Plans are to build a 1.5 km (4920 ft.) test track with ten vehicles at the Siemen facility in Erlangen. A one to two-year test program would start early in 1976.

Technical characteristics of H-Bahn are as follows:

Guideway. _. _ - _.	Hollow steel box beam, l meter(39.4 in) deep. Slot on the bottom through which the vehicle is suspended.
Stations- - _ - _ ----	On and off-line. 20-second delay for a 3-berth station.
Vehicles. - _ - _ - _ --	16-passenger maximum capacity. Two 4-abreast seats facing 8 standees in the middle.
Suspension -------	Steel wheels with composite facings run on the inside bottom surface of the box beam. Lateral guidance is provided by rubber wheels which press on the vertical upper inside surface of the box beam.
Propulsion -------	Two l-sided linear synchronous electric motors. Used asynchronously during acceleration and braking.
Controls ---------	Speed and position control determined by spacing of iron cores in the track.
Speed-----------	35 km/hr (21 mph).
Headways -------	80 meters (260 feet). Based on a braking distance of 50 meters and a 7.5 meter fixed block sensing system using inductive loops in the track.
Operations --------	Vehicle flow-4,50/hr. Seats—3,600/hr.

H-Bahn is conceived as a GRT s~~stem offering demand-type service over a coarse network of lines.

The Nlinistry of Research and Technology has allocated 8.5-million DN1 ($3-million) for H-Bahn development over the period from 1 ,Januarry 1973 through 30 April 1975.

1 Kom~akfbahn.—G1onceptllnlizati{)n and design of an intermediate capacitj" AGT system by Krupp Industries and Stahlbau began in Jully 1974. Fom vehicle sizes under study are described below:

Vehicle type	Capacity, Seated	Capacity, standing	Total	Vehicle height Meters	Vehicle height Feet	Track width Meters	Track width Feet
AO. . . . .,	32	28	60	2.0	6.6	2.2	7.2
Al, ...		20		2.0			
A2. ... ... , ,, ...	x		i%	1.5	:::	: : :	H
A3.			18 18	1.5	4.9	1.3	4.3

All vehicles are 8 meters (26.2 feet) long with a minimum turn radius of 9 meters (29.5 feet), Operations me on line with vehicles run singly or in trains. Guideway's are reinforced concrete channels to guide the rubber-tired vehicles. No other technical det ails me available.

The Ministry for Research and Technology has allocated 3.4-million DM ($1 .2-million) to the project for the period 1 ,JulJ' 1974 to 30 June 1975. Plans are to condurt tests on a 1,000-meter (3,280-foot) closed loop test track at the I{rupp works, Proposecl test facilities include a switrh, passenger loading station and a varie~~- of guideway materials. Tests would begin in 1976 and be completed m 1977.

JAPAN

The greatest interest in AGT development has been shown by the Japanese. They have imported systems from Boeing Morgantown), LTV Aerospace (AI RTRAA[T]S) and Bendix Dashave}ror). Five other SLT or GRT systems are under development by Japanese industry.

The Ministry of International Trade and Industry has sponsored development of the world's most sophisticated PRT system—CVS (Computer-controlled Vehicle System). In addition, a small dual-mode vehicle system, also called CVS, will be demonstrated at the International Ocean Exposition on Okinawa in July 1975.

The CVS developrnent is described below. Characteristics of the other systems are summarized at the end of this section.

CViS.-This PRT system has been under development in Japan since 1968. At that time preparations were made for a "traffic game" to be demonstrated at the Osaka World Exposition, which was held from March to September 1970. The demonstration in the Automobile Industries Pavilion consisted. of more than ten specially designed electric vehicles operating indlvldually under computer control on a checkerboard-like guideway network with intersections every five meters (16.4 feet). The two-seat vehicles communicated with the central computer through an underground communication channel.

Though primarily designe() as an exhibition facility, this demonstration accomplished several things, includmg:

- Development of elementary computer logic for controlling a small fleet of vehicles.
- Development of techniques for managing vehicle grade crossings on a highly integrated network of intersections.
- Assessment of public attitudes toward the use of small, tiutomated vehicles.

The basic concept for CVS was formulated in July 1970. In the autumn of 1970 work on the basic design of the system began with support of the Ministry of International Trade and Industry (MITI). Miniature models of vehicles and a glideway were constructed. A total system with 1,000 vehicles was simulated on a. large computer as the basis for preparing fundamental techmcal specflcations.

Based **on** this research, a reduced-scale experiment was preptired from April to October 1971. Cars for a network representing the central 300-meter" square area (984 feet) of the Ginza District in Tokyo. CVS cars at 1 :20 scale were operated under computer control for the public at the 18th Tokyo Motor show from 28 October to 21 November 1971. Though the velllcles and guldeway were one-twentieth scale, the computer-control system was full scale. Thus, the experiment provided an opportumt)' to exercise both the computer hardware and software for an extensive automated network system.

At the conclusion of the Tokyo Motor Show in November 1971, full-scale development of CVS began. hlITI financed construction of test facilities on the site of Japan's first automobile test track at Higashimurayarna, about 30 ,km (18 milep) wept of Tokyo. The test-track configuration is shown m the follo\\-mg diagram. An aerial view of the CVS test facilities are shown on the next page.

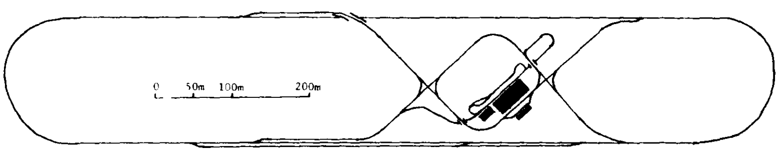
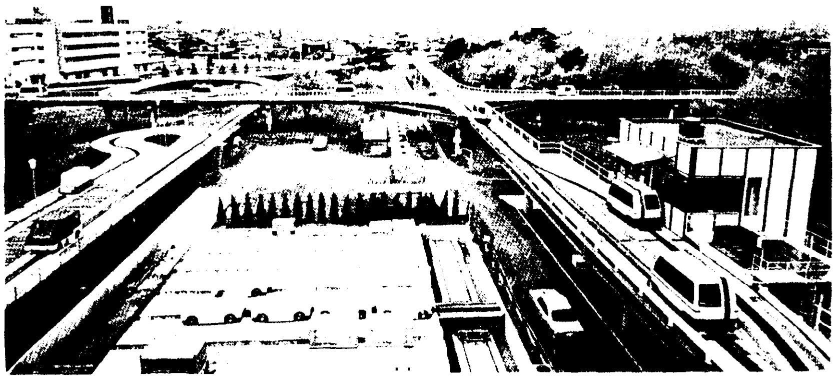


Figure 8.—CVS Test Track Configuration, Higashimurayama Tokyo, Japan. (The maintenance area and an off-line station are shown within the 100-meter grid in the middle of the test loop.)

The total length of the guideway is 4.8 km (2.9 miles). At the top of the diagram, 2 km of straight track permit high speed operations at 60–80 km/hr (36–48 mph). Two parallel traffic lanes at the bottom of the diagram permit, high-speed lane changing experiments. The diamond-shaped portion in the center represents the grid in a low-speed network. One side of the grid is 100 meters (328 feet) long, which is technicall~: the minimum distance betw'een stations. The test track is designed with two at-grade crossings to check performance of the vehicle control system at these intersections. The telephone-shaped track inside the grid has a circular guideway with a radius of 5 meters (16.4 feet) at both ends and is used as a maintenance mea. The control center, vehicle storage yard and passenger cargo station are below the maintenance truck. A second passenger/cargo station is located at midpoint on the upper high-speed track.



CVS Project Experimental Center—Higashimurayama, Tokyo, Japan. (Vehicle storage in the foreground, off-line station at the right and at grade intersection at the right rear.)

Control System

The CVS system is controlled by a synchronous moving block system using three separate computer systems. The first one is the Hitachi computer system, which controls the vehicles high speed operation, i.e., the outer-ring (speed betw-een 40-60 knl/hr) ; the second is the Toshiba computer system controlling the low speed operation, i.e., the inner-ring (speeds below 40 km/hr) and moving blocks on the guidway; the third one is the Fujitsu computer system which functions as the supervisory computer, controlling overall SJ stem operation, and monitors the other two computer systems.

Vehicles

While originally planned for a 100-vehicle test operation, inflation has reduced the scope to 60 vehicles, as follows:

	Phase 1	Phase 2
"All up" vehicles:		
Passenger	0	13
Cargo	o	6
"Testbed" chassis:		
Passenger	16	27
Cargo	8	14
Total	24	60

All vehicles have been delivered tothe site, but test operations will be scheduled over two phases discussed in a following section.

A variety of vehicle configurations are available for testing. The "all-up" versions are complete prototypes, whereas the 'itest-bed" chassis contain only the essential propulsion, control and braking systems. Passenger vehicles generally have four seats—facing backwards for safety purposes. Standing is not permitted on automated transit s stems in Japan. Other passenger-carrying versions have forward facing seats; two of the seats can be folded to provide space for a baby carriage or hand baggage. The following photograph shows **a** CVS passenger vehicle manufactured by the Toyo Kogyo CovLtd.

The cargo vehicles are designed witha capacity of300to 400kg (660-880 pounds), and since the vehicleshaveno springs, they remain level with the cargo platform. Three versions have been observed: a flat-bed type with two conveyor belts built into the floor, a panel truck type and apostal truck type.

CVS Passenger Vehicle

System Characteristics

The following is a summary of the main CVS characteristics:

Guideway. _ --.-.	Steel "I" -beams for the running surface.
	Steel sections for the guide groove containing controls and power rails.
	Dimensions: 2m (6.6 ft) wide, 0.8m (2.6 ft) deep.
	Span: 20-30m (66-98 ft).
	Maximum Grade: 10 percent.
	Minimum Radius: 5m (16.4 ft).
Stations- --------	Passenger or cargo,
	Off-line.
	Minimum spacing: IOOm (328 ft).
Vehicles- --------	4 passengers (all seated).
	Pneumatic rubber tires.
	Propulsion: 200v AC motor.
Speed- ----------	Normal: 40 km/hr (24 mph).
	High Speed: 60 km/hr (36 mph).
	~%~;i~;m: 80 km/hr (48 mph).
Headways.. ------	
Braking ---------	Electric regenerative for high speeds—O.2 G.
	Friction for low speeds—O.2 G and 0.5 G.
	Emergency, explosive activated—2.O G.
Operations -------	Per lane: 3,600 veh/hr 14,400 seats/hr.
	Entrained operations are contemplated with 20 to 30 passengers/train.

Program Schedule

The Higashimurayama project begain in 1971 and its basic design was completed by the middle of 1972. In the autumn of the same year the maintenance guideway and the first experimental vehicle were completed. Basic driving tests under manual control commenced shortly thereafter. In the spring of 1973 basic experiments with computer control began. The full length of guideway was constructed in the autumn of 1973. At this time the second stage of experiments began, including: computer control of several vehicles, operations for passenger service at stations, control of automatic loading and unloading of freight containers, lane changing experiments and overtaking of vehicles at high speed.

Phase I of the Higashimurayama project will extend through the spring of 1976. The objective during this phase is to accumulate itemized basic experimental data. Condensed experiments will be conducted to maximize the capability of vehicles to follow the guide target. The system reliability including the reliability of mobile communications between the vehicle and the wayside computer. Phase I is intended to prove the technical practicability of CVS through item tests of components and subsystems.

Speed tests have been conducted at 60 km/hr (36 mph) and headways of five seconds have been consistently achieved at 20 to 30 km/hr (12 to 18 mph). No attempt has been made to test operations at headways close to one second. To reduce risks to equipment and vehicles, the short-headway tests will not be attempted until they can be carried out safely, sometime during Phase II.

The second phase will last several years, starting in the spring of 1976. The urpose of Phase II is to conduct a total trial of the system, with 60 veFicles operating on the test track under complete computer control. This phase will be primarily concerned with cargo operations, and will not emphasize passenger transport. Reliable and consistent one-second headways will be attempted with those vehicles designed for such operations. Phase II will also incorporate mechanisms for collision avoidance, obstacle detection/avoidance, and a 0.5 G emergency braking system.

Observations

Those who have had an opportunity to visit Higashimurayama generally have the following observations:

- The test facilities and scope of the experimental operations are impressive.
- The three-tiered computer control system seems unnecessarily complex. The Japanese claim it was no more difficult to design the computer interfaces than a single computer system to do all the necessary functions.
- Use of an explosive-actuated emergency brake to avoid a catastrophic collision would produce a 2.0 G deceleration force. While passengers face backwards on high-backed seats to minimize the effect of such an instantaneous stop, there is concern that injuries may still occur.

Project Management

The CVS Project is under the general direction of MITI and is sponsored by the Japan Society for the Promotion of Machine Industry (JSPMI). The Ministry has spent approximately $10 million to date on the project, mostly for the test track and related facilities. JSPMI channels funds derived from other industry associations to help fund the project.

A consortium of eight private industrial firms share in the cost and provide technical resources. These firms are:

Toyo Kog~o
Mitsubishi Jukogyo
Tokyo Shibaura Denki
Hitachi Seisakusho
Fugi~su
Sumltomo Denki Kogyo
Nippon Denki
Shm-Nihon Seitetsu

The CVS Project is managed by a team from Tokyo University and MITI.

Other Japanese A(7T Systems.—Of the eight SLT or GRT systems under development, three are based on United States Technology. Two of these three systems—KRT (Boeing) and NTS (LTV)—are pictured on the next pa e. Vehicles for the third system, Dashaveyor (Bendix), have been sol% but not shipped to Japan. The main features of all eight systems are summarized in Table 3.

Another transit system known as "Beltica" has been developed by the Fuchu Worfis of Toshiba Electric Co. Ltd. A prototype system with 400 meters (1,312 feet) of track and one vehicle has been built and operated at the Toshiba plant. Vehicle capacity is 20 with five seated and 15 standees. The vehicle is propelled by a continuously moving rubber belt within vertical concrete guide rails. Both the car and a belt on the passenger platform move at 1.5 mph for loading and unloading. After leaving the station, the vehicle is accelerated to 15 mph by powered wheels in the guideway. Though no operator is on board the vehicle, the moving-way technology employed as well as the short distances (0.5 to 4 km, 0.3 to 2.4 mi) and high capacities (40,000 passengers per hour) preclude further assessment as an AGT system.

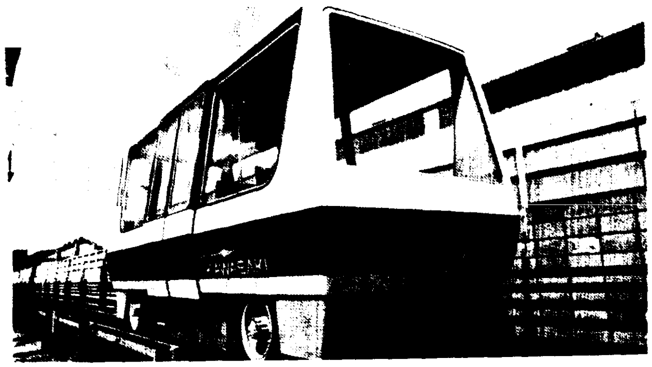
JAPANESE SLT/GRT VEHICLES

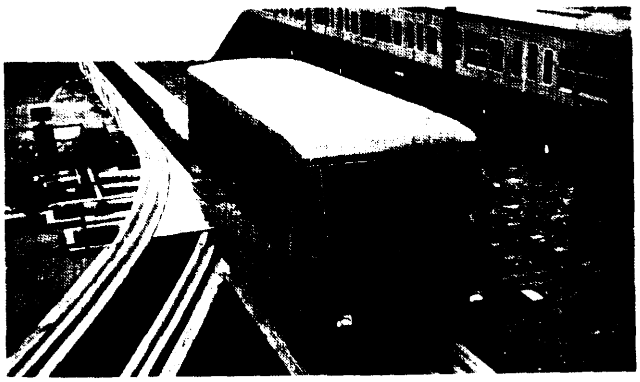
MAT

Mitsubishi Heavy Industry, Ltd., 32-Passenger Vehicle

KCV

Kawasaki Heavy Industry, Ltd., 30 to 50-Passenger Vehicle





ParaTran

Hitachi 40-Passenger Vehicle

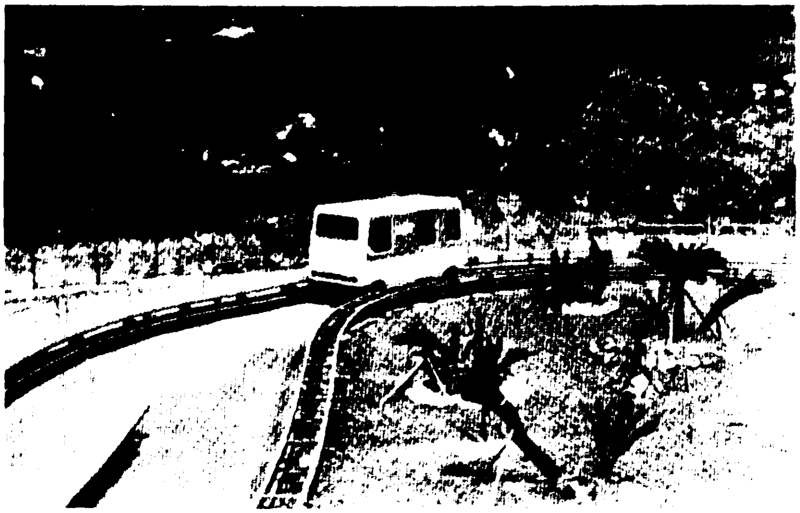
Table 3: FEATURES OF EACH SYSTEM

Item		KGV	NAT	Mini Monorail	NTS	Paratran	KRT	VONA	Dashaveyor
	Developer	Kawasaki Heavy Fuji Electric	Mitsubishi Heavy Industry*	Toshiba, Anzen Sakudo	Niigata Tekko, Sumitomo Ele	Hitachi Sharyo	Tokyo Kobe Steel, Nisho Iwai Trading	Nihon Mitsui Trading	Bendix/ Dashaveyor
	Guideway Type	Guiding at sides	Guiding in Middle	Mounting type, Small monorail	Guiding at sides	Guiding inside or rails	Guiding at sides	Guiding in middle	Guiding at sides
	Development Stage	Test Track	Test Track	Design	Test track (licensing by LTV)	Test track	Licensing by Boeing	Test track (Yazu Park Oper.)	Test track Transpo 72
Vehicle	Standard Capacity	(1) 50 (2) 30	32	(3) 22 (4) 25 (5) 25	50 (seats 20)	40	25-70	30	(8) 36 (seats 12) (9) 4-6 (all seated)
Vehicle	L x W x H (m)	(1) 9.1 x 2.35 x 3.15 (2) 6.35 x 2.35 x 3.15	5.17 x 2.2 x 2.9	(3) 7.15 x 2.0 x 2.4 (4) 4.5 x 2.0 x 2.4 (5) 5.475 x 2.0 x 2.4	7.5 x 2.3 x 3.4	7.0 x 2.2 x 3.15	4.7 x 2.0 x 2.7	(6) 5.8 x 2.0 x 3.0 (7) 5.3 x 2.06 x 3.06	(8) 7.2 x 2.2 x 3.2 (9) 3.4 x 1.6 x .17
Vehicle	Empty Height (ton)	(1) 8.5 (2) 4.5	4.5~5.0	(3) 6.8 (4) 3.8 (5) 4.5	6.4	5.5	3.9	(6) 5.5 or less (7) 5.0 or less	(8) 6.5 (9) 1.1
Vehicle	Tires	4 Rubber Tires	4 Rubber Tires	4 Rubber Tires	4 rubber tires	8 rubber tires	4 robber tires	4 rubber tires	4 rubber tires
Power	Voltage	3φ AC 440/400V	3φ 550V	3φ AC 440/400V	3φ AC 440/400V	3φ 440/400V	AC 600V	DC 600V	(8) AC 3.09 (9) DC 480V
Power	Traction Motors	(1) 50~65kw x 2 (2) 50~65kw x 1	265 kw	45 kw	50-70 KW	55 KW	75 PS	55 KW	(8) 30 Ps x 2 (9) 15 PS x 2
Perform	Max. Speed (kmph/mph)	75/45	60/36	60/36	60/36	60/36	64/38	60/36	(8) 65139 (9) 48129
Perform	Max. Grade (%)	10	10	10	10	10	10	10	10
Perform	Min. Turning (m/ft)	(1) 20/66 (2) 12/39	10/33	15/49	25182	30/98	9/30	20/66	(8) 23/75 (9) 6/20
Guideway	Beam Material	Steel or Concrete	I Steel	Box Steel	Concrete	Concrete	Steel or concrete	I - steel	Concrete or Steel
Guideway	Standard Span (m/ft)	15/49	15/49	20/66	20/66	15/49	15149	10-17/33-56	(8) 15/49 (9) 251S2
Guideway	Post Material	Steel pipe or concrete	Steel pipe or concrete	Steel	Concrete	Steel pipe or concrete	Steel	Steel pipe	Steel or concrete
Guideway	Stitching	Vertical	Rotating (180°)	Horizontal	Switching blade	Block type	On Board Type	Horizontal Swing	(8) Vertical (9) Horizontal
Guideway	Switching Time (sec)		6	8	3	4	1.2	5	(8) 4 (9) 1
Operation	Control	central, automatic & Floating	Central, automatic & Floating	Central, automatic & Floating	central, automatic & floating	central, automatic & floating	Central, automatic & floating	Central, automatic floating	Central, automatic & floating
Operation	Min. Headway (sec)		90	120	20	90	10	90	(8) 15, (9) 5-8
Operation	Max. capacity (Psn/hr)	(1) 28&2 (2) 17,000	20,000	12,000	20,000	19,000	16,000	19,000	(8) 21,000 (9) 5,000
Notes:		(1): KCV-12 (2): KCV-13	*Mitsubishi Electric Mitsubishi Trading	(1): front car (2): middle car (3): rear car	*Toyo Electric Sumitomo Trading			(6): front car (7): following car	(8): GRT (9): PRT

Source: Handling Tomorrow's Transportation Today: The New Transportation System; Japan Transportation Planning Association.

EXAMPLES OF U.S. TECHNOLOGY USED IN JAPAN

Test Track built by LTV Licensees, Niigata Engineering Co. and Sumitomo Shoji Kaisha, Ltd.



Kobe Rapid Transit (KRT) System for Expo '75 on Okinawa. Built by Kobe Steel, Ltd. in cooperation with Boeing Aerospace Co.

Chapter 5: -Acquisition Procedures

The development and deployment of new transportation systems, such as A GT, depend upon the institutional and financial procedures available in the sponsoring countries. The days are long gone when a priviate inventor or entrepreneur could muster enough cspital and political license to build an innovative transportation system in the expectation that fares would realize a profit on the scheme. The success of transportation innovation depends on government involvement, industry incentives and institutional-political considerations which establish the climate for innovation.

GOVERNMENT INVOLVEMENT

Policies and procedures adopted by federal and local governments have a msjor effect on the realization of new system concepts. Policies on sponsoring and funding, proprietary rights, contracting procedures for both development and construction, and continuity of support influence the outcome of such efforts. Government involvement can set the pace for innovation or can interfere with attempts to do so.

SPONSORING AND FUNDING

Research and Development

The derision to sponsor and fund R & D for AGT systems development recognizes the need for transportation alternatives beyond the capability of local governments or any one industrial compsny. Federal goverm\nment financial involvement absorbs some or all of the risks and provides an incentive for development of AGT alternatives. The opportunities for exporting systems has also figured in decisions to sponsor and fund AGT system development. CVS development in Japan is under the general direction of the Ministry of International Trade and Industry (MITT), not by the Ministries of Transportation and Construction who would normally have responsibilities for installations of such a system. In England, the Programmes Analysis Unit, a joint unit of the Department of Industry and United Kingdom Atomic Energy Authority, completed a study, in 1974 of the likely export market for systems developed in the United Kingdom. Recent endeavors to establish licensing agreements reinforce the idea that foreign decisions to sponsor and fund AGT system development recognize the potential world-wide export market.

In England, AGT hardware development has been 100 percent funded by the Department of the Environment. The work has been accomplished through the government research establishments in the belief this procedure produces the most robust results. Functional specifications for hardware performance have been drawn up by external consultants under contract to either local or national government bodies. Propositions from the small companies can be presented to the government and to the National Research and Development Corporation for funding. No recent transit proposals have been worthy of support by these means.

The French government uses a variety of techniques, many similar to those employed in the United States, to stimulate industry and university laboratories to engage in the research, development and commercialization of new systems. Some techniques act directly. Examples are loans, grants and reimbursable advances. Others have an indirect effect, with examples being tax policies and measures to stimulate the creation of private venture capital.

The following techniques are worthy of particular note because they tire not presently practiced at all or to the same degree in the United States.

Reimbursable Advances.—In the development stage of new systems, when the developer must invest in expensive prototype hardware and software, the government and the company enter into a shared-cost contract based upon the estimated total cost for the project. Typically, the government agrees to provide a 50 percent cash advance, payable periodically at pre-determined dates. The company agrees to generate the balance during the term of the project in my form accountable on the company's books. The government allows the company to possess the proprietary rights to the system and to commercialize it; however, the company must agree to the following:

- To pay a royalty (typically about 2 percent) on the value, less taxes, of each commercial sale of the system.
- To pay a royalty (typically as much as 30 percent) of royalties received from third parties who sell the system under lcenses from the company.
- To continue to pay royalties to the government until the government's cash advance, plus interest (at a rate established in the contract), has been fully repaid,

If the first phase has gone well, and If the system prototype is in good running order, the government will increase the share of financing for subsequent phases.

Assistance to Inventors.—A special agency of the French government, the National Office for Dissemination of Research (ANVAR), was established in July 1968 to stimulate invention. It provides several kinds of assistance. It can make, for example, small financial advances that me reimbursable in amounts and according to a schedule which is a function of revenues from future sales. It can also establish a special entity to assist the inventor in bringing the invention to the status of commercial exploitation. In addition, it can make available up to a maximum of 20 percent of the capital of an existing company to help strengthen its capability to adopt the invention.

In contrast to practices in other countries, the Federal German Ministry for Research and Technology has not ordered AGT developments, but pays 80 percent of the development costs. The remaining 20 percent must be borne by the developing companies. This cost-sharing is to the advantage of the government in that only those projects are furthered which are liable to succeed but which are too expensive for industry alone.

The sponsored development is carefully controlled by:

- . Critical discussions in annual status seminaries, during which the development team has to present their results and further Planning in the presence of their competitors.
- independent experts.
- A project monitor, who controls critical cost, time and work schedules.

The Ministry for Research and Technology, however, leaves the entire power of decision and complete responsibility for the direction of development to the developing industry. The Ministry neither directly nor indirectly participates in the development and does not give technical directions. In this way, the expenses of governmental administration are minimized and the developing industry can react very flexibly to altered circumstances.

Construction

Procedures for financing the construction of AGT systems also vary among foreign countries. In Jap)an, the government (princi])all~' the Ministry of Construction) could finance up to 50 percent of the cost. This share would cover the fixed facilities considered part of the road and street network. The source of these funds would be gasoline tax relenues. The remaining costs would be divided between the local government or municipality, and the operating agency. The operating agency would collect revenues, meet operating? financing and depreciation costs, and retain any profits. The Ministry of Construction appears to favor ownership and operation by a governmental agency. The Ministry of Transportation seems to favor private owner operations and is considering procedures whereby a private operator could be loaned funds for system development and installation. After acceptance test approval, the Ministry of Transportation would no longer be involved in system operations.

Procedures are similar in West Germany, except that federal and state (lander) governments would finance up to 80 percent of the fixed facilities. The federal share would be 60 percent and the state would provide 20 percent. The municipality would cover the remaining 20 percent of the fixed instillation and 100 percent of the vehicle costs.

In France, the government can provide up to 50 percent of the capital costs for public transport. Most important, it will finance up to 70 percent if new technology systems are being introduced. A law introtuced in July 1973 permits the local share to be derived from a salary' tax imposed on emplo~-ers of more than nine people in an urban area. with a population of more than **300,000.** In special cases, even smaller towns qllalify.

In the Unite(l King(lom, allocation of funds for the requisition of a transit s~wtem is made through the Transportation Polic~- and Programme proced~we. Each ~"ear each county (state) prepares a document, the "TPP", which states its policy intentions to allocate its transport funds over the next five ~'ears. A district counci] and county council would have to agree to i~corporate an AGT system for the town in the TPP. The Secretary of State for the En~Tironment, on the basis of the total set of TTPs submitted, and the amount of money avadable, allocutes funds to the local governments through a Transport Supplementary Grant.

PROPRIETARY RIGHTS

Foreign governments differ with the United States government in their treatment of data and patents considered proprietary by system developers. Though foreign government funds are used to reduce concepts to operating prototypes and to develop and test new systems, the proprietary rights remain with the foreign private developer. In France, even the prototype hardware and software belongs to the company, except that if the company fails to achieve a commercial success with the system, the prototypes may revert to the government. Furthermore, the government must wait at least 12 months before releasing data or other information about the system to any third parties and may be limited beyond 12 months from releasing information considered to be company-confidential. In ,Japan, patent rights stemming from CVS development are jointly owned by the Japan Society for the Promotion of Machine Industry and the eight participating enterprises.

In the United States, R & D accomplished with Federal funds generally requires the relinquishment of proprietary rights. While the specific requirements vary with contract negotiations, the general implication is that United States developers are at a disadvantage in terms of exploiting new developments. (This subject is discussed in greater detail in Chapter 3, Volume 1).

CONTRACTING PROCEDURES

Research and Development

Foreign R & D depends to a greater degree on private initiatives than it does in the United States. As mentioned above, initiatives for AGT development in Germany originate with private industry. In France, development occurs in collaboration with both a system supplier and another transport agency or government body. Sole-source contracts are used extensively, but there are exceptions. The development of VAL, in conjunction with the new French town of Lille-Est, responded to a competition based on a request for proposals initiated by EPALE, the local public planning authority.

Sole-source development contracts arc considered advantageous in that the costs of preparing competing proposals are eliminated. There is believed to be a greater commitment to achieve company motivated performance than to satisfy system specifications drawn up by others. The disadvantages to sole-source contracts are that costs may not be the lowest for comparable effort and potential sources may be excluded from the development. Nevertheless, officials in England, France and Germany consider that their present R & D programs embrace the systems worthy of development.

AGT development procedures in England most nearly match those in the United States. The Department of the Environment, which has responsibility for transportation planning, construction and operations in the United Kingdom, initiated development of the Minitram system through a field agency, the Transport and Road Research Laboratory, Competitive feasibility studies for hardware concepts htive been undertaken. In addition, the laborator~~ has commissioned detailed planning, engineering and operating feasibility studies for a demonstration system in Sheffield. The resulting report, *Minitram in Shefield*, was published in October]974. The Department of the Environment must be satisfied with the technical feasibility of the project. The Sheffield metropolitan District Council must decide whether to participate in the demonstration project.

The practice of planning demonstration installations in parallel with technical development is used in most foreign countries. This procedure has not been commonly used in the United States. The main advantages in the practice are that hardware development is conditioned by the realities of feasible deployment and planning is kept pragmatic by the realities of achievable system designs. The disadvantagc is that technical development could be curtailed if city officials disapprove a demonstration installation.

Construction

Actual construction of operating AGT systems abroad has not been sufficient to assess differences in constructlon contracting procedures. However, various procedures have been considered and the Panel on International Developments considered it important to include a discussion of the significant procedures in this report.

Public works contracts.-~lost public agencies prefer, or are required by law, to acquire facilities through typical public works contracting procedures. Under these procedures, plans and specifications are prepared for various elements of a transit system, competitively advertised and awarded to the lowest price, responsible, and responsive bidder.

Tile public agency administers and inspects the construction and installation as lt progresses.

ADVANTAGES

- The procedure is well-known; contract administration would be straightforward.
- Maximum competition could be achieved with some opportunities for small local contracting firms.

DISADVANTAGES

- There is no standardization of AGT technology. Standardization would prematurely preclude competition among s~'stem suppliers. The lack of standardization makes difficult the engineering design and construction of fixed facilities through public w'orks contracting procedures.
- The guideways represent 50 to 70 percent of the cost of an AGT installation. Separation of this clement and other fixed facilities may]eavc a vehicle supplier with 10 to 20 percent of the project funds, but with most of the exposure for success or failure of the system.
- Public agencies have little capability or experience in the integration management of such a system. This service can be performed by a consultant organization, hilt the illtimate responsibility for the performance and satisfactory operation of the system rests with the vehic]e supplier. however, uncler

typical public works contracting procedures the vehicle supplier has virtually no authority over features that would interface with the vehicle, such as: guideway configuration, power rails, automatic control system.

Systems Integration Management.—Under this procedure the public agency retains a non-hardware, consulting engineering organization, to plan, design, and prepare bidding documents for the AGT installation. The consultant would be responsible for managing the integration of all elements of the system, reviewing the technical adequacy and prices of proposals, and would supervise the installation. The public agency would control funds, advertise and award contracts.

ADVANTAGES

- A qualified organization can provide special competence not normally available in the public agency.
- Interface problems are minimized and can readily be resolved when they occur.
- Maximum competition is preserved.
- The technique has been successfully used in space, defense and rail rapid transit programs.

DISADVANTAGES

- The total project cost may be increased, but this cost is likely to be far less than the overruns resulting from the lack of integration management.
- There are few non-hardware firms with extensive experience in managing the installation of AGT systems.

Turn-Key Contracts. -Under these procedures, the public agency would complete all preliminary engineering, including foundation analyses, site surveying, locating underground utilities, right-of-way acquisition, and make this data available m the bid-reformation package. A system supplier is selected from competitive proposals responsive to a performance specification, and would be responsible for the final engineering, system integration management, construction, vehicle fabrication and pre-acceptance system testing. The system supplier is responsible and has authority for the scope of the work—he is held accountable to a public agency for performance of the system within agreed upon costs and time schedules.

ADVANTAGES

- The vehicle supplier, with the greatest technical knowledge of his system, has responsibility for satisfactory performance.
- Competition among system suppliers is preserved, avoiding a premature rejection of alternatives.
- The vehicle supplier can make the most cost-effective tradeoffs on such features as ride comfort involving guideway roughness and vehicle suspension.

DISADVANTAGES

- While there is competition among suppliers, and subcontracts for certain features (guideways) could be competitively awarded, other elements would be proprietary to the system and may not be bid.

- This procedure can be the most costly since the vehicle supplier is performing the integration management and would base his profits and overhead on the total project cost.
- Most system suppliers have had only limited experience in managing construction contracts.

CONTINUITY OF SUPPORT

A long-range commitment to a development project is necessary if there is to be a reasonable chance for success. Appropriate check points should be included in a development plan to review progress and to determine whether to proceed or terminate, but these check points may not coincide with the start-stop cycle of fiscal year appropriations. Continuity of support for development programs abroad depends on the way some foreign governments are organized.

In Germany and Japan, technical development of AGT systems tends to be separated from agencies having responsibility for construction and operation of revenue systems. The German Ministry for Research and Technology undertakes development through test operations of prototype systems The Ministry of Transportation budgets funds for urban demonstration and revenue installations. The Japanese Ministry of International Trade and Industry manages the long-range development of CVS while the Ministries of Construction and Transportation share responsibilities for installation and operation of available AGT systems. Such separations have the advantage in that competition for resources to solve immediate transportation problems is avoided, at least within one ministry. The arrangement has two major disadvantages. Organizations responsible for the eventual installation and operation of the new systems are not involved in their development. Planning considerations may not be adequately addressed, unless parallel studies are undertaken, as described above.

The continuity of support is provided by other means. In Germany, the Ministry for Research and Technology has established a program through 1978 with a budget of 350-million DM ($125-million). Development of AGT systems is a major part of this program. In France, the government's current five year plan makes a commitment to commercial experiments with AGT systems in medium-sized towns. Grants are available for R & D. This form of government planning and commitment has encouraged the early marriage of a system supplier and local municipality described in Chapter 3.

INDUSTRY INCENTIVES

Most foreign AGT system development has been initiated by private industry. For many of the developers this endeavor was regarded as a logical expansion of traditional transit supply activities or diversification from military and aerospace production. While governments have encouraged AGT development, private firms were expected to independently develop a potential product before government support was made available.

For those industries which have taken the initiative in supporting initial development and are willing to share costs up to system commercialization, a variety of incentives are available.

Costg sharing.—As discussed above, governments may reimburse from 50 to 80 percent, or even 100 percent, of the development costs. As the Krauss-Maffei experience with Transurban indicated, government support is not interminable. However, foreign developers can expect consistent government cost sharing throughout the life of the project. This practice contrasts with typica] United States procedures which establish ceilings on the amount of financial support with no relief from full contractual obligations.

Recouery of costs.—As is the practice with R & D procurement contracts in the United States, foreign development also requires the payment of royalties to recover the government share of costs. However, these royalties may be reduced if a lower rate would help the company win an export sale in a competition. Furthermore, the recovery of cost provisions are regarded as an incentive for commercialization. Government agencies in France, Germany. and Japan actively participate in endeavors to achieve the commercial success of systems at home and abroad.

Insurance against loss.—A technique used by France in other areas of transportation which may be applied in the AGT market is a government guarantee against loss in the marketplace. This protection is made available to stimulate a company to invest in production facilities and marketing activities when the product is socially desirable but is risky to commercialize, In effect, the government guarantees the company a minimum financial return sufficient to cover the company break-even costs. The measure is the difference between actual sales and the company's break-even point if the actual sales generate a lower value.

INSTITUTIONAL AND POLITICAL CONSIDERATIONS

There are differences in foreign institutional and political arrangements for sponsoring the acquisition of AGT systems which offer both advantages and disadvantages in comparison with procedures in the United States. Since there are no AGT installations abroad which compare with those made in the United States it is too early to judge the effectiveness of the foreign institutional and political arrangements. However, to the extent that United States practices are found wanting, foreign procedures are worth~" of consideration.

COOPERATION BETWEEN SYSTEM MANUFACTURERS AN-D LOCAL GOVERNMENTS

Concurrent system development and planning is fostered through the close cooperation of manufacturers and local governments. System developers in Germany and Japan have been involved in detailed planning studies for the installation and operation of their systems. This cooperation has aided the developer in defining development requirements. It has also helped the public agency in evaluating alternative solutions to local transportation problems. So far as is known, this cooperation has not resulted in commitments for engineering design. or construction of an AGT installation in Germany.

In France, local governments are encouraged to initiate innovative transit solutions. Contractual arrangements with a system supplier define the scope of activities relatlve to planning and pricing the installation. Negotiations lead to early decisions concerning the type of system to be installed, the scope and staging of the project. Projects which have national interest and are consistent with the government's five-year plan become eligible for financing from various ministries having cognizance of land use, regional development, transportation and public works. The project is managed by representatives from these ministries in addition to officials from the local and regional planning agencies and transit operating authority.

The main advantage to early cooperation between supplier and local government is that planning tends to be more pragmatic. The system manufacturer becomes aware of performance requirements which must be achieved through his development programs. Local planners can incorporate specific system characteristics rather than leave them unresolved until a final system choice is made. Early involvement of a system supplier has other advantages. The cost of preparing and evaluating competitive proposals is avoided. The developer is encouraged to proceed with confidence that if there is to be a commercial installation, it will be his, thus assuring a return on his development investments. Government participation in the project will underwrite the supplier's development costs. One successful installation will enable a system supplier to write off costs for preproduction engineering and tooling.

There are disadvantages to such a cooperative arrangement. System selection may be based on entrepreneurial influence without an objective evalutaon of potentially- more competent systems. Without price competition, obtaining the least costly installation becomes much more difficult. If parallel development IS not successful, some planning efforts could be wasted and installation would be delayed.

GOVERXIIENT-INDUSTRY COOPERATION

While llnprecedented in the United States, government-industr~' ronsortia nre w-idel~" used thmughollt Europe and Japan as a means to accomplish research nnd development an(l to penetrate the commercial market. In German?'j L'abinentaxi development is being accomplished throllgh a joint ventllre involving DE31ACI Forclertechnik and 31essers{:hrnitt-Bf) lko\~~-BlohIll GInbH. in Japan a consortitlm of eight Pril'ate inC{11strie5, ~ tra(]e associ ii tion, tl~e ~~niversit~' of '1'ok~'o and the hl inistr~- of Int erntit ional Trade and Industrj- me cooperating on the development, find the test facilities for tl~e Compllter-controlled l'chicle S~wtem (L'J'TS). The ~~inistr~ of Construction in Japan has organized an ~lll tolna teC I (]lla l-nloc~e blls developtnent group involving 17 private enterprises. The total cost of this latter pro~oect is estimated at nbout $5.5 -nlillion; abotlt one-fourth of the cost WI1l be subsidized by the l[inistr~' of (.'onstr~lction.

While a consortium is cliffiiclllt to manage, the arrangement has several advantages:

- The best talent of industr~ specialties can be concentrated on a particular development project.
- ,Scarce resources, inc]uding personnel, capital and facilities, can be conscr~'ed b~- aloiding competition between participants.
- Go ~"ernnlent expend it ures are reduced through cost sharing with industrl.

. Because the government is a participant, there is mutual interest in commercialization of the product. Both the government and industry stand to get a return on the initial investments.

. To strengthen the price advantage of the consortium in an initial foreign competition, the government can waive the recovery of cost provisions for the industry participants.

These advantages, available to foreign AGT system developers, have placed United States manufacturers at a competitive disadvantage.

GOVERNIIENT CORPORATION

Government corporations have been established for conducting R & D and for managing the commercialization of results. In the United Kingdom, the National Research and Development Corporation was set up by the government to invest in new technological development with a responsibility for breakin even in its operation "taking one year with another". In July 1973, tie Province of Ontario, Canada, established an Urban Transportation Development Corporation (UTDC). Other provinces and the Canadian Federal government are expected to become share-holders in this corporation.

The objectives of the Corporation are to:

. Acquire, develop, adapt, use and license patents, inventions, desi ns and systems for all or any part of transit systems relatei to public transportation and rights and interests therein or thereto.

. Encourage and assist in the creation, development and diversification of Canadian businesses, resources, properties and research facilities related to public transportation.

. Undertake the design, development, construction, testing, operation, manufacture and sale of all or any part of transit systems related to public transportation.

. Test or operate and provide services and facilities for all or any part of transit systems related to public transportation and in connection therewith build, establish, maintain and operate, in Ontario or elsewhere, alone or in conjunction with others, either on its own behalf or as agent for others, all services and facilities expedient or useful for such purposes, using and adapting any improvement or invention for any means of public transortation.

. .Ganufacture vehicles and control, propulsion and guideway systems and their appurtenances and other instruments and plant used in connection with transit systems related to public transportation as the Corporation may consider advisable and acquire, purchase, sell, license or lease the same and rights relating thereto, and build, establish, construct, acquire, lease, maintain, operate, sell or let all or any part of transit systems related to public transportation in Ontario or elsewhere.

. Carry on any other trade or business that, in the opinion of the Board, can be carried on advantageously by the corporation in connection with or as ancillary to the carrying out of the objectives of the Corporation set out above.

The goal of UTDC is to improve the quality of urban life through innovations in transit. The company operates as a private, for-profit, corporation with a management team and a board of directors representing a broad cross-section of private and public interests. Technical and management staff within the corporation are directly engaged in immediate and long-range development of transit concepts, products and systems. In addition UTDC retains the assistance of consultants from Canadian universities and industry.

In addition to the development and demonstration of an AGT system, UTDC has inaugurated development of a small bus and a light rail vehicle. Originally designed for dial-a-bus service, the small bus is being configured to accommodate handicapped persons in wheel chairs. The light rail vehicle will incorporate the most modern technology available for Canadian operating requirements.

Establishment of the UTDC required the government to appropriate a $6 million working fund and to delegate authority to enter mto specific kinds of contracts. Once estabhshed, the UTDC is expected to proceed with developing and marketing new transportation systems, depending upon the cash flow from these operations to preclude the need for extensive additional government aid. This independence provides continuity. to development programs since they are not subject to fluctuations m annual appropriations.

Chapter 6: Findings and Summary

Significant finding: from this assessment of foreign AGT develop- -merit are summarized as follows:

- Foreign technical developments are more ambitious than those in the United States. Actual technical accomplishments are comparable at present but foreign developments will surpass those in the United States by 1979 if all present programs are carried out as planned.
- No nation has an ideal organizational arrangement for the development and deployment of AGT systems. France appears to use one of the best procedures but the lack of any actual revenue installations makes judgment difficult at this time. All other countries, including the United States, have a serious gap between programs to develop and test AGT systems and programs to install and operate AGT systems in revenue service.
- Foreign developments are focused on the solution of urban transportation problems. There are no foreign deployments comparable to those in the United States, but those being planned will provide transit in urban areas in contrast to the highly specialized areas served by United States systems.
- Foreign development procedures offer potential system suppliers many advantages not available to United States developers.
- Other institutional arrangements for the development and deployment of AGT systems are worthy of consideration. Alternatives such as a national development corporation or a consortium of cities and industries merit serious consideration.
- Licensing arrangements which export and import foreign technology are Proliferating. Whether market expansion will make these agreements 'worthwhile-remains to be seen.

International developments of AGT systems are earnest. They are focused on meeting anticipated deficiencies in existing transit systems and providing alternatives to increasing dependence on the automobile with its attendant problems of congestion and use of petroleum fuel. Foreign developments also have an eye on a potential United States market and within four years will be able to offer AGT systems more attractive than an~' under development in the United States at present.

SUMMARY

An assessment of foreign development can be summarized as follows:

. Technical development is comparable to that which has been achieved in the United States. There are differences in specific accomplishments:

The United States lags by about four years in the acquisition of test facilities comparable to those of the Japanese for CVS or the Germans for Cabinentaxi. However, no foreign deployments of AGT systems have been made which are comparable to the airport installations in Tampa, Sea~tle.-Tacoma, and Dallas/Ft. Worth, or to Morgantown, West Vwgnua.

Development goals for the foreign systems are generally more ambitious than those in the United States. For example:

	Foreign	United States
Headways	1.0 second and less.	3.0 seconds.
l-way line capacities (seats per hour).	16,000 (maximum).	14,400 (maximum).
Velocities (miles per hour):		
Maximum	22.4 to 50.	40 to 55.
Cruise.	22.4 to 37.	16 to 40.

The state-of-the-art in braking, propulsion and control technology is approximately the same for both United States and foreign developments. Thus, there are less risks in achieving the 6ited States goals than there are for the foreign programs.

- Differences in the way foreign governments are organized to sponsor AGT system development offer both advantages and disadvantages in comparison with United States procedures:

In Germany and Japan, technical development of AGT systems tends to be separated from agencies having responsibility for construction and operation of revenue systems. This separation has an advantage in that it tends to insure continuity of development by avoiding competition for resources to solve immediate transportation problems. Such separation has a disadvantage in that system development tends to be aloof from the problems of deployment. In both Germany and Japan, the system developers have been involved in planning large urban AGT networks. However, this planning has been more concerned ~vith defining development efforts than with planning the actual installatlon and operation of a system.

In France, AGT development has generally been initiated by local governments in conjunction with a hardware supplier. This arrangement leads to early decisions as to the type of system to be incorporated in the local transportation improvement program. If the planned development is of national interest, financial assistance can be made available from various ministries having cognizance of land use, regional development, transportation and public works. Representatives of local and regional planning and operating agencies, in addition to representatives from these ministries, participate in management of the project. One advantage to this arrangement is that planning tends to be more pragmatic with early heavy involvement of a specific system supplier. Another advantage is that market uncertainties are reduced through commitments to a supplier that his system, if any, will be installed. Once the hardware decision is made, wasteful competition is eliminated. This arrangement has disadvantages. System selection may be based on entrepreneurial prowess. Absence of price competition may not produce the least costly installation. It is too early to judge whether this management procedure offers the best solutions to both the technical and implementation problems of an AGT system.

AGT development procedures in England most nearly match those in the United States. The one ministry having cognizance of transportation planning, construction and operations is sponsoring AGT development through a field laboratory. The laboratory- has sponsored detailed planning studies for a demonstration installation, but—as in the United States—the city selected will have the final say as to whether it will host the project. This procedure has the advantage of keeping a focus on the realities of eventual deployment. The disadvantage is that technical development may be truncated if a city demonstration is not forthcoming.

- Deployments of AGT systems in the United States have been in hlghll- specialized areas-parks, airports, commercial developments and a university campus. NO comparable instillations have been built overseas. As mentioned above, foreign planning for large-scale networks has been associate(l wltb definition of harware requirements. Planning for actual deplo~ment is limited to SLT or GRT systems of modest scope. m le significant difference is that concrete planning for foreign installations is predominantly for urban, rather than special uses. Though installations at airports ancl medical centers are contempltitecl, principal applications are as follows:

  ~ew towns or residential complexes near existing cities would be served with SLT or GRT s~-stems to provide some internal service and to connect these towns to existing rail lines in the adjacent cit,~-.

  ,Sorne existing older t owms have experienced population growth tind increased automobile usage. ll~here the resulting traffic congestion and decline in transit usage is not readil~~ correctable b~" conventional means, national governments have encour~gecl innovation with AGT systems. Either SLT or GRT s]:stems would augment existing transit service and open up possibilities for auto-free, pedestrian malls served b~- the new transit s~-stem.

- Foreign ;}-stem developers frequently have an advantage over their Umted States counterparts. Preelection through noncompetitive procedures is common (France). Consortia of several industries are fostered b~" the national governments to develop ~~ particular concept (Germtin~' and Japan). Private capital ma~- sponsor research and development through the concept stage. If the concept is found attractive, the government can offer nltin~" incentives for protot)pe development and testing, including:

  Cost sharing with a 50 percent cash advance.

  Compan~' retention of proprietary rights for commercialization with payment of modest royalties.

  Companyt retention of hardware, software and data rights. Government financial support for a local development and demonstration project virtuall~~ insures the company against losses for investments in production facilities and engmeerin~. This insurance is a strong incentive for a developer to explolt his system commercially. Successful commercialization is an advantage to the government since royalties are paid to the government until the initial cash advances, with interest, are fully repaid. Thus, the government is motivated to encourage adoption of new systems to secure a return of the investment in the initial development.

. Other institutional arrangements for developing AGT systems are worth noting.

The Ontario government in Canada has established an Urban Transportation Development Corporation (UTDC). The Canadian government, as well as other provincial governments, me expected to participate in the development programs. The role of this corporation is to:

Coordinate and promote the development of advanced technology of all types relating to public transit and to integrate this development with the design and production of conventional transit facilities.

Fund research in transit innovations in intermediate capacity systems and others.

Market systems through the private sector in Ontario and Canada.

Under the Government of Ontario, the UTDC has authority to:

Acquire and hold license rights for Canadian and foreign developments pursuant to contracts for present and future related technology.

Retain patents and industrial property for system applications in Canada.

Develop an export market from which it would receive a percentage of royalty income.

Sublicense companies in Canada for the manufacture and sale of complete transit systems, subsystems, and components.

Establishment of the UTDC required the government to appropriate a $6-million working fund and to delegate authority to enter into specific kinds of contracts. Once established, the UTDC is expected to proceed with developing and marketing systems, such as AGT, depending upon the cash flow from these operations to preclude the need for extensive additional government aid. This independence provides continuity to development programs since they are not subject to fluctuations in annual appropriations. There are precedents in the United States for similar institutional arrangements in the establishment of the Communications Satellite Corporation and passage of the Solar Heating and Cooling Demonstration Act of 1974.

Institutional arrangements used in Japan for development of CVS are somewhat more complex. The project is under the general direction of the Ministry of International Trade and Industry (MITI), which provided the test facilities at Japan's first automobile proving grounds in Higashimuryama, Tokyo. Sponsorship is provided by the Japan Society for the Promotion of Machine Industry. This society channels funds derived from other industry associations to finance the development project. A consortium of eight industries share in the cost and provide technical resources. A team from Tokyo University and MITI comprise the management of the CVS project. This approach, using management by committees, has produced some significant results:

In six years, the most ambitious PRT development program in the world has progressed from conceptual planning to a sophisticated test program involving 60 vehicles and 4.8 km of test track.

Government expenditures *on* the development have been less than $10 million to date. However, arrangements between three responsible Ministries (International Tracie and Industry, Construction, and Transportation) have yet to be devised which will make a revenue installation possible.

. World-wide interest in AGT systems has produced several international licensing arrangements.

Three United States companies have licensing agreements with Japanese organizations. (LTV) Aerospace corporation, the Boeing Company, find the Bendix Aerospace Corporation.)

The otis Transportation Technology Division has an understanding with SOCEA, an engineering and construction subsidiary of Saint Gobain-Pent a' Mousson to plan and build an AGT system in Nancy, France.

Kralws-hIaffei of Munich, Germany, has a licensing agreement with the Urban Transportation Development Corporation, Toronto, Ontario, Canada.

LTV)' and their French licensee, C0MSIP Enterprise, jointly bid a variation of the AIRTRANS system for the new Charles de Gaulle Airport.

Several United States companies are pursuing licensing agreements with European developers. Both European and Japanese developers are actively seeking United States licensees. W'hether the AGT market will materialize in a way that could make these licenses profitable remains to be seen.

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APPENDIX A

BIOGRAPHIES

MEMBERS OF THE PANEL ON INTERNATIONAL DEVELOPMENTS

H. Wm. Merritt, Chairman
Transportation Consultant
Arlington, Virginia

H. Wm. Merritt directed the Study of New Systems of Urban Transportation for HUD in 1967–1968. Until 1973 he was the Associate Administrator for Research and the Director, Special Projects, in UMTA. Since 1973, he has consulted on urban transportation plannin , engineering, and energy conservation. Mr. Merritt chairs a task force of the# ational Academy of Sciences which publishes a Newsletter on New Concepts of Urban Transportation.

Robert A. Burco, President
Public Policy Research Associates
Berkeley, California

Robert A. Burco specializes in urban transportation system evaluation, institutional aspects of planning and public policy and technology assessment. In 1971–1972 he assessed innovations in urban transit in Europe, North America and Japan for OECD. Mr. Burco authorized the 1968 SRI report on impacts of future urban transportation systems. He is a member of the OTA Urban Mass Transit Advisory Panel and the NAS Transportation Research Board.

Thomas H. Floyd, Jr.
Vice President DGA International
}1'ashington, D,C.

Mr. Floyd is currently involved in the transfer of European technology and industrial innovations to the United States, specializing in ground transportation. Prior to his association with I)GA International in 1969, Mr. Floyd was the director of research project management in the Urban Mass Transportation Administration. In this capacity, he was responsible for the planning and management of research, development and demonstration programs.

Howard R. Ross
Transportation Consultant
Menlo Park, California

Mr. Ross has worked in the urban transportation field for over ten years, and h specialized in problems of advanced technology systems. since lgi'1, he has headed a consulting firm dealing with system design and analysis, technolog~" forecasting, transportation planning, financial studies and economic analyses for urban transit systems. Mr. Ross was a founder of Transportation Technology Incorporated in 1968, and prior to that was at Stanford Research Institute.

APPENDIX B

INTERNATIONAL CONTRIBUTIONS

The panel gratefully acknowledges information on international developments provided by the following individuals:

JAPAN

Mr. Takuji Masuda, Policy Planning Officer (Urban Traffic), Minister's Secretariat, Ministry of Transport.

Mr. Kazuhiro Sate, Social Systems Development Office, Ministry of International Trade and Industry.

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Mr. Michel Frybourg, Director, Transportation Research Institute.

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Dipl-Kfm G. von Lieres u. Wilkau, Manager External Relations, Messerschrnitt - Bolkow-Blohm.

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