Chapter V

IMPACTS OF ADVANCED GROUP RAPID TRANSIT TECHNOLOGY

Systems derived from advanced [illegible] transit (AGT) technology have the potential to [illegible] the [illegible] and quality of urban [illegible]

The first of the [illegible] group rapid transit (AGRT) [illegible] This issue has been [illegible] vanced AGT [illegible] modes. The [illegible]

- **quality of service** [illegible]
- **the auto user** [illegible]
- **ridership** • [illegible] • [illegible] and productivity

Quality of Service

The advantages of AGRT over other transit modes are due to:

1. its unique ability to provide station-to-station service with no transfers and few stops on its own right-of-way, and
2. its high availability at all times of day due to automation.

It can also provide high-capacity service by running multicar trains over fixed routes on fixed schedules.

The Urban Mass Transportation Administration (UMTA) has yet to perform important computer simulations and other studies that would indicate the congestion impacts caused by large numbers of people trying to use the system and that would indicate the tradeoffs among vehicle size, system configuration, trip patterns, and other design and operating decisions.

The quality of service offered by a transportation mode is measured by such variables as time, cost, comfort, convenience, reliability y, availability y, and coverage. Assuming that AGRT would be operated and managed as well as existing transit systems, its inherent advantages are its potential for station-to-station service with no transfers and few stops and its availability at all times of day. While it could only provide the same amount of coverage as a bus system at appreciable cost, it would provide superior service on all other variables (assuming the security and emergency evacuation questions can be adequately addressed). The guarantee of a seat, the possibility of on-demand service, and the prospect of fewer transfers could give AGRT a distinct advantage over other grade-separated modes as well.

The flexibility of AGRT will allow it to respond to changing demand levels. At periods of low utilization, the service would be "demand-responsive, " with vehicles being routed to stations as service requests are generated. Such trips would involve minimal stops and no transfers. During periods of higher demand, the vehicles can be operated in trains on fixed schedules, over prescribed routes, serving small clusters of stations. In this latter case, service would be similar to that of a conventional rail system. *

* In this manner it has been claimed that AGRT could be adaptable to share the transit burden in relieving a "fuel crisis, " being able to offer the same line-haul capacity as heavy-rail systems. While existing guideways would be adequate within a given coverage area, stations would have to be enlarged and additional vehicles and attendant facilities acquired.

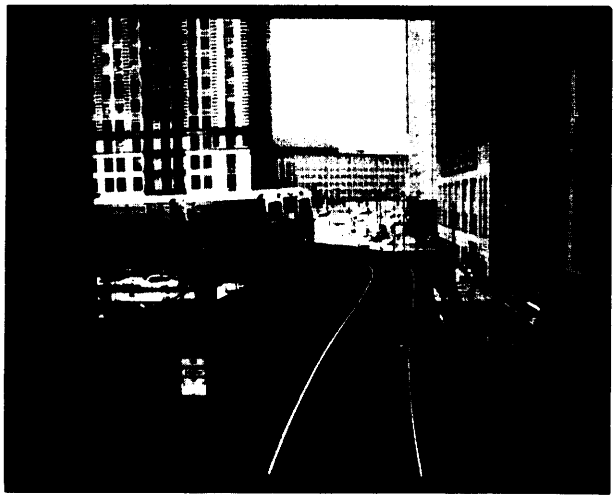

Photo credit OTA s/a// photo

Wide-elevated guideways create visual blight but easier emergency evacuation

There are other amenities that can be provided to make transit travel comfortable and convenient. Some of these, such as air-conditioning, barrier-free access, seat comfort, sound deadening, and simplified fare collection, are not inherently unique to AGRT. Decisions to implement AGRT rather than other options should not be based on these factors.

UMTA material indicates that AGRT has a capacity of 14,400 persons per lane per hour for its AGRT systems. [1] In practice it is virtually impossible to achieve these capacities with single 12-passenger vehicles operating individually at 3-second headways. Guideways and stations, like highways, are subject to congestion that would severely impair service levels, i.e., time, convenience, comfort, reliability. AGRT vehicles operated in tandem could actually achieve much higher capacities. Detailed computer simulations to show the various tradeoffs of cost, travel time, capacity, and other factors are needed to shed more light on this critical issue.

Unresolved issue:

the relationship between service levels, passenger trip demands, and other factors.

[1] U. S. Department of Transportation, Urban Mass Transportation Administration, Request for Proposal (RFP) DOT-UT-300 14, High Performance Personal Rapid Transit (HPPRT) System," Feb. 20, 1974.

The Auto User

If provided with sufficient capacity, and if available at all times, AGRT should be a more attractive alternative to the automobile than conventional transit modes.

The major rationale for AGRT is that it will help to reduce auto usage and all the attendant negative impacts the auto has on the urban environment and on national energy policy. In many areas auto disincentives are being proposed to help deter people from driving, particularly when they drive alone, in congested city districts, or during peak periods. However, for these disincentives (such as auto-restricted zones or increased tolls or parking charges) to be effective at instigating a shift to a transit alternative, the transit systems must possess two important attributes:

1. capacity (to handle the influx) and
2. a level of service close to that of the automobile.

For AGRT to truly be an effective alternative to the auto, sufficient capacity must be provided to serve the new riders abandoning their automobiles. In this respect AGRT is no different than any other transit mode. But where AGRT can truly be an advantage over automobile usage is with some of the service attributes discussed above under “Quality of Service. ” AGRT would certainly be more attractive than buses in mixed traffic. Because of its ability to provide more stations at a fixed cost than light- and heavy-rail guideway systems and to offer nonstop non-transfer service, AGRT should, in most instances, appear at least as attractive as conventional fixed guideway systems. Another very important factor is that AGRT would be available at all times of day, 7 days a week, a feature absent from most transit systems today. Thus, for those auto users who would wish to travel by transit or who might otherwise be deterred from continuing to drive, AGRT should be more attractive than conventional modes if capacity can be provided to meet demand.

Ridership

The service attributes of AGRT should enable it to attract significantly more riders than ordinary bus service and at least as many riders as other guideway modes. But additional studies are needed to determine consumer reactions and the magnitude of ridership impacts.

The service potential for an AGRT system is similar to an automated shared-ride taxi taking a rider from origin to destination with only a small number of stops. In theory, any system could be operated in this manner. In practice, only a small-vehicle system can efficiently provide point-to-point (or, in this case, station-to-station) service without having either excess capacity or a large number of stops.

On an overall basis when AGRT is compared with transit modes operating in mixed traffic, it will attract higher ridership in the general areas covered because of its superior speed, comfort, and reliability. It will also benefit from allowing most passengers to complete the AGRT portion of their trip without transferring. *

AGRT has no inherent speed advantage over conventional rail systems, but could attract higher ridership due to its better coverage (for a given construction budget) and reduced transfer potential. Not enough is known about how consumers would react toward UMTA's AGRT concept, versus a well-managed modern rail system with guaranteed seating. It is likely that the choice between these two options would be based on local factors in addition to ridership forecasts, although AGRT should prove relatively more cost-effective for lower volume grade-separated installations. As noted in the previous section, AGRT could be spoiled by its own success—with higher volumes congesting the system, lowering service levels, and necessitating additional capital facilities.

Unresolved issues:

- consumer reaction to advanced automated systems versus other grade-separated technology and
- the congestion impacts caused by a large number of people trying to use the system.

*With heavy ridership preliminary analysis has Indicated that it may be more efficaceous to operate AGRT with a series of overlapping fixed routes on fixed frequencies. In this manner some passengers may have to transfer. For on-demand service, it appears that all riders would receive a direct rldc

Special User Groups

Because of its potential for providing broad geographic coverage and station-to-station nontransfer service, AGRT can provide significant service improvements for special user groups.

In every urban area there are large numbers of people whose mobility needs require special attention in planning and designing public transportation services. For the poor, the cost and availability of public transportation are critical variables; for the handicapped and elderly, physical accessibility to vehicles and stations is of utmost importance if they are to have a P1ace in the mainstream of American life. Other groups requiring special attention are women and the young.

As a new mode, AGRT vehicles and stations would be designed to be in compliance with accessibility regulations of section 16(b)2 of the Urban Mass Transportation Act of 1964 (as amended)[2] and section 504 of the Rehabilitation Act of 1974.[3] However, any other federally assisted new mode or new facilities (fixed or rolling) must also meet these requirements. The inherent characteristics of AGRT do appear to offer some advantages to these special user groups.

For all user groups, automated guideway systems would be superior to nonautomated transit modes because of their availability at all times of day and night. Because of automation, service levels do not have to be sharply lowered in offpeak hours to save the costs of operators or attendants. The transit-dependent, particularly low-income shift workers, would benefit from this. Women, in particular, would benefit from the absence of long waits at isolated unprotected bus stops after dark. The handicapped and elderly would benefit from shorter waits for service, in contrast to long waits and unreliable service frequently experienced with buses operating on local streets, The absence of transfers on fixed guideway systems (whether automated or not) would also make travel easier. (On an all-bus system many of the handicapped are realistically limited to traveling to destinations ly - ing along only those bus routes passing very close to their residences.)

If AGRT can meet its construction cost goals, then more extensive coverage can be provided than with other fixed guideway systems (for similar construction budgets). If such coverage was provided in suburban areas, inner city workers would have better accessibility to outlying job opportunities than they would have with conventional fixed-rail systems.

There are two potential disadvantages to AGRT. First, if AGRT is provided in place of local bus service there will be fewer access points to the system. Second, satisfactory solutions for emergency evacuation need to be found that meet the requirements for the handicapped and elderly, particularly when suspended or narrow guideway systems are being considered.

Wider doorways to stations and vehicles as well as escalators and/or elevators for level changes would be an asset for all transit riders. But most particularly they would benefit the handicapped and elderly in comparison to what conventional alternatives provide. However, there is little reason to believe that the same accommodations cannot be provided on conventional systems. Thus, decisions to proceed with AGRT development to aid special user groups should consider the aspects of geographic coverage and transfers.

‘Urban Mass Transportation Act of 1964, Public Law 88-365, 78 Stat. 302, U.S. C. vol. 49, sec. 1601 et seq. (as amended), sec. 16(b) 2.

‘Rehabilitation Act of 1974.

Safety and Security

Automation enhances the safety (collision avoidance) of guideway transit systems.

Passenger security is perceived as a problem when the ride must be shared with strangers, particularly on small vehicles with infrequent stops.

Methods to provide security in unattended vehicles and user response to such methods, remain as unresolved issues.

Wide= guideway bottom-supported systems offer the most satisfactory opportunities for emergency evacuation procedures. Narrow guideway systerns are potentially less costly, less obtrusive, and less subject to winter weather operating problems; but no satisfactory emergency evacuation strategy has been developed for them.

Automation can enhance safety by eliminating accidents due to human error and equipment failure. Those AGT systems already in operation have exhibited superior safety performance since they first began operation in 1971. ~

Security issues arise from uncertainties regarding public acceptance of unattended stations and vehicles. Unattended platforms are common in many transit systems and all bus stops are, in fact unattended stations. The more limited number of waiting points in AGRT would appear easier to monitor and control. (Similarly, a heavy-rail system with yet fewer stations might offer a further advantage.) Research has shown that crime rates at transit stations parallel those of adjacent neighborhoods. [s] Design guidelines are being prepared which stress adequate lighting and unobstructed visibility. Such treatment should reduce station security problems for AGRT and other systems to a minimum.

Photo credit L TVAC PR&A

Automated systems have proven safe in nonurban settings

[4]The MITRE Corporation, *Urban Applications of Advanced Group RapidTransit A) I Alternatives Analysis* Study, September **1978, p. 140.**

'Ib]d., p. 144.

There is little experience from which to assess security in unattended vehicles. Currently deployed systems in Morgantown, W. Va.; in the Dallas-Fort Worth Airport; and in numerous other airports, theme parks, and zoos have had few problems; but none of these systems operate in a typical urban environment.

Fire presents a very difficult problem for all transit modes. Vehicles are vulnerable to fire in the passenger compartments, in undervehicle equipment, and on nearby property. In-vehicle fires can be controlled with a more judicious choice of materials, a solution available to all modes. However, should fire occur on or under a vehicle, the location of the vehicle will be crucial. Vehicles on the surface have the best chance of being evacuated; passengers can walk away from fires in tunnels if they are not overcome by smoke. Vehicles supported on wide guideway elevated structures can utilize the built-in walkways; however, no generally acceptable solutions are yet available for narrow guideways and suspended vehicles. Conventionally powered AGRT, with a proliferation of traction and control units, has a greater probability of failure and delay than larger vehicle systems. On existing elevated systems it is also common practice to close sections of guideway when fire occurs on adjacent property. Most of the concerns over fire also apply to the need for emergency evacuation of accident victims.

Unresolved issues:

- methods to provide security in unattended vehicles (and user response to such systems) and
- emergency evacuation procedures.

Urban Development

Fixed guideway systems that provide not only line=haul service but also circulation and distribution within activity centers may enhance urban development potentials of the area served.

Urban development tends to occur in areas having high accessibility. Transit systems enhance accessibility in station areas and thus support development and redevelopment when carried out in conjunction with other positive development policies such as zoning changes and economic incentives.

AGRT systems, by providing many small stations rather than a few large stations, should encourage medium-density development at many nodes, as opposed to higher densities at a few concentrated points. By combining line-haul and distribution service, AGRT systems should be able to effectively serve dispersed activity centers designed for automobile access. This latter attribute suggests that AGRT systems may prove more effective than existing transit modes in enabling central-city residents to obtain access to jobs in lower density suburban locations.

Many existing Federal programs influence urban development patterns: housing, highways, water supply, waste treatment, and economic development to name a few. The AGRT program goals should be made consistent with a common set of Federal policy goals.

Unresolved issues:

- the effects of AGRT systems on land use development patterns and
- the relationship of AGRT and its potential urban applications to the programs and policies of the Department of Housing and Urban Development, the Environmental Protection Agency, and other relevant agencies.

Energy and Environment

To the degree that the service characteristics of AGRT systems attract travelers to use transit rather than the private low-occupancy auto, electrically powered systems should make a positive contribution to petroleum con= servation and maintenance of environmental quality.

For highly concentrated large travel demands, large-vehicle systems will be more energy-efficient. For periods of low demand, small vehicles operated as needed, without the requirement to provide scheduled service, will permit energy savings by tailoring supply to demand. Selection of an optimum vehicle size would have to follow an analysis of local 24-hour service needs.

Noise impacts of guideway systems will depend partially on the technology utilized. Rubber-tired vehicles would probably be similar to vans or panel trucks in noise impact. Air cushion systems, as in the proposed Otis vehicle, appear to be fairly quiet. Magnetic levitation and linear motor technology with no moving parts for propulsion or suspension should be very quiet.

The visual impacts of elevated guideways are a very localized and subjective matter. In the city of Miami, for example, both the rapid rail and downtown people mover (DPM) systems will be elevated. This form is apparently acceptable to the public in both residential areas and scenic areas such as Biscayne Boulevard. Miami Beach, however, rejected the area's elevated rapid rail alternative because of the elevated profile. In Denver the elevated guideway issue was also polarizing. From the rider's point of view, elevated travel may be more pleasing than at-grade or underground service.

Electrically powered transit systems can help reduce air pollution to the extent that persons can be attracted out of private autos. However, the overall effect of any benefits will depend on the environmental characteristics of the power source.

Snow and ice present particularly perplexing problems for transit. Elevated guideway systems could cause an environmental nuisance if snow and ice fall or drip on passers-by. Removing them can entail great costs in energy and manpower, if a complete shutdown is not forced altogether. During the harsh winter of 1976-77, more money was spent on the Morgantown system for natural gas to heat the guideway than for electricity during the full 12-month period. '

'N. D. Lea & Associates, Inc., *Summary of Capital and Operations and Maintenance Cost Experience of Automated Guideway Transit Systems*, June 1978, pp. 17-18.

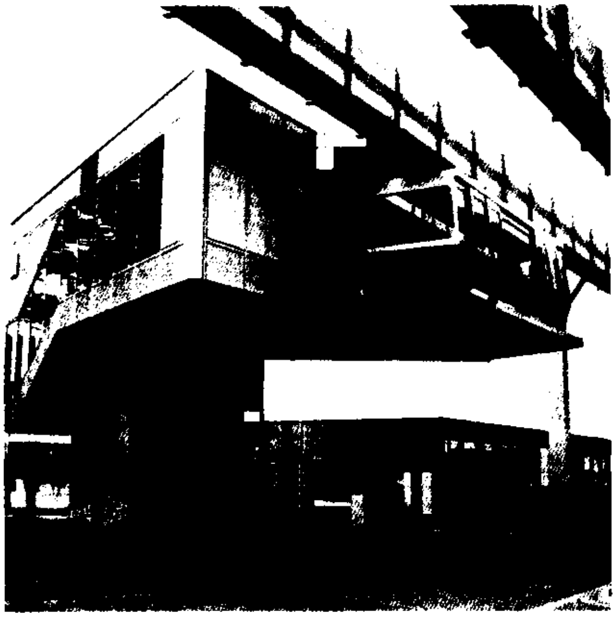

Photo credit Siemens

Photo credit DEMAG Fördertechnik

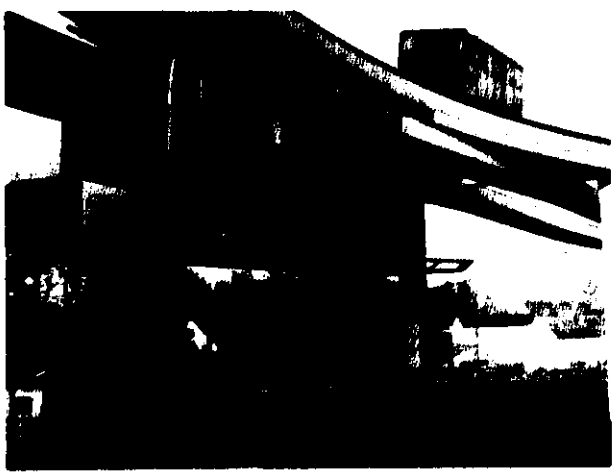

Photo credit Siemens

Suspended vehicles are less bothered by ice and snow. Narrow guideways are less obtrusive, but emergency evacuation is a problem

An I-beam (monorail) .design would accumulate less snow than some proposed U-shaped designs that actually trap it. (The latter probably would permit less dripping.) Keeping the power rails free from ice, snow, and frost is also an important consideration in assuring service dependability.

Unresolved issues:

- esthetics of elevated guideways,
- an energy-efficient solution to maintaining operations during ice and snow conditions, and
- optimum vehicle size and speed for energy efficiency.

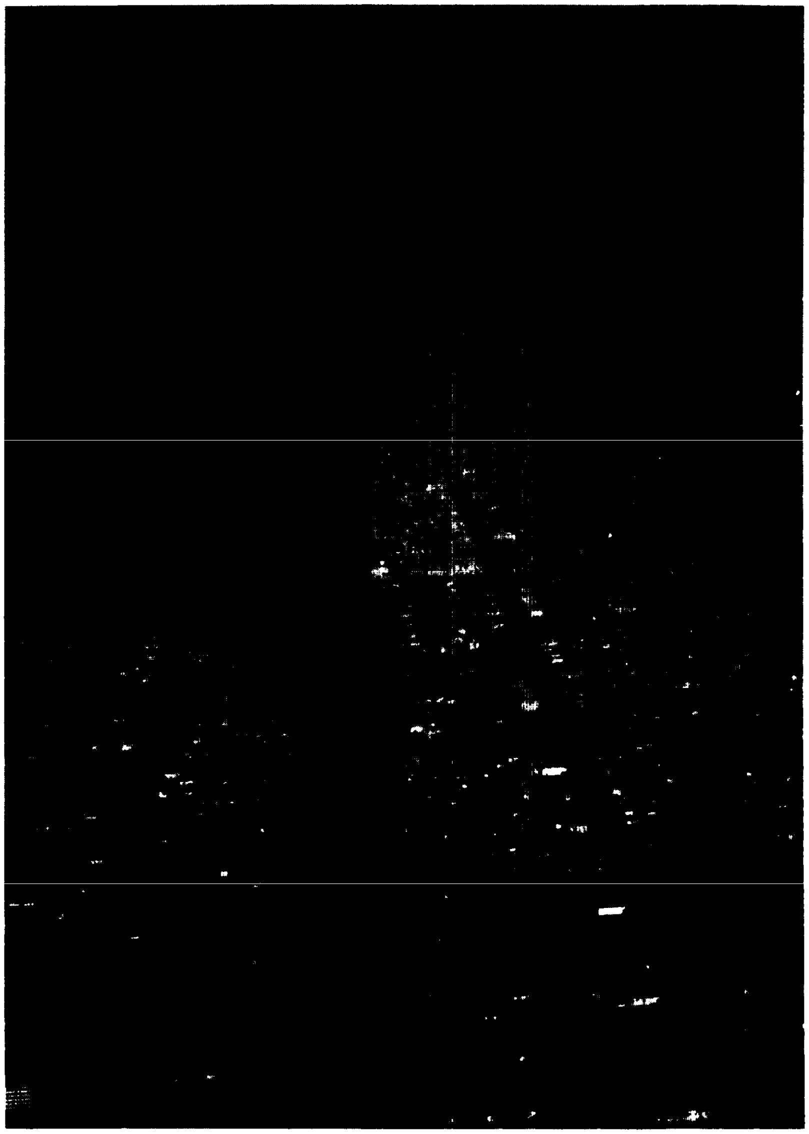

Photo credit: OTA staff photo

Electric-powered transit can help reduce air pollution

Economics

Advanced AGT systems offer the potential to reduce the cost of public transit. However, wide variations in estimates of capital and operating costs, for both automated guideway and existing systems, do not permit definitive cost comparisons to be made at this time.

Local site conditions and preferences may be more important factors in system selection than the inherent economic characteristics of AGRT.

Although claims have been made that AGRT can reduce the costs of urban transit operation, the data are not available to substantiate these generalized claims. As recommended in OTA's 1975 report on AGT, UMTA undertook a program of socioeconomic research in conjunction with the new systems development program. Two studies on this topic have been completed, and two more are underway.

- The MITRE Corporation, *Urban Application of Advanced Group Rapid Transit: An Alternative Analysis Study,* September 1978.
- N. D. Lea & Associates, Inc., *Summary* of *Capital and Operations and Maintenance Cost Experience* of *Automated Guideway Transit Systems,* June 1978.
- Cambridge Systematic, Inc., "AGT Markets Study" (in progress).
- Barton-Aschman Associates, Inc., "Generic Alternatives Study" (in progress).

The MITRE study indicated that AGRT could improve transit ridership but the findings on system economics cannot be generalized. The N. D. Lea study summarized the cost experience of 10 existing systems, mostly in airports and theme parks. Generally, these systems are very limited in mileage and the results of their operating experience are not directly applicable to AGRT. Cambridge Systematic and Barton-Aschman are doing further research on AGT markets with added emphasis on the "image" of these systems. The first study is investigating AGT in general; the second is comparing AGRT with 28 other modes or modal combinations.

One of the major decisions in urban transit is whether or not to invest in the high costs of exclusive rights-of-way and grade separations for transit vehicles, be they bus, light rail, heavy rail, or AGT. Such guideways free transit from the constraints and problems of mixed traffic operations and provide significantly better levels of service. However, it is not clear that certain operating economies made possible by an exclusive right-of-way will lower operating costs sufficiently to recover fully the investment in guideway and stations.

When AGRT is compared to conventional transportation modes on a lifecycle-cost' basis there is too much variability and uncertainty in the available data to come to any generalized findings. There are many tradeoffs involved and wide ranges of parameter values within any given mode. When the AGRT technology is available for urban deployments, local site conditions and preferences may be more important factors in system selection than the inherent economic characteristics of AGRT.

Because UMTA's program has centered on a discrete set of AGRT specifications, data are not available on other size vehicles or other system configurations. It may be desirable to conduct system optimization studies to determine the attributes of a broad range of AGT configurations for different applications before prototype systems are designed.

A critical element of AGT costs is the design of the guideway. Narrow deep cross-sections are most efficient from a structural point of view and may also be less obtrusive. Suspended systems, such as Romag, are usually of such a design, but supported systems can also be designed as efficiently. U-shaped cross-sections are

'U. S Congress, Office of Technology Assessment *Automated Guideway Transit* OTA-T-8 (Washington, D. C.: U.S. Government Printing Office, February 1975).

*Lifecycle costs include operating and maintenance costs together with the cost of capital structures and equipment over the life of the facility.

much less efficient and in addition collect more snow and ice in adverse weather environments.

Unresolved issues:

- the attainability of operating and maintenance cost goals,
- the uncertainty of capital costs for various configurations and the extent to which these may be reduced by improved guideway design, and
- optimum vehicle and operating procedures for various applications.

Employment and Productivity

The data are not available to determine the extent to which AGRT might be more labor-productive than other transit modes. UMTA should investigate the potential reduction of jobs for unskilled persons brought about by sub= stituting automated systems for manually operated systems.

Several questions have arisen concerning the size and mix of labor skills required to operate and maintain AGT systems:

1. Will deployment of automated systems significantly increase or decrease the total size of the transit labor force?
2. What skill mix of workers will be required?
3. Over what time frame would any changes occur?

There are no clear-cut answers to these questions.

Impact of AGRT on size of labor force

Automated guideway vehicles will operate without attendants and it is presumed stations would be unattended. However, automated guideway systems have a long list of labor categories to fill: mechanics, machinists, electricians, cleaners, maintainers for all major systems (guideway, power distribution, substations), technicians (for fare-collection machinery, elevators, escalators, and communications equipment), and police, as well as engineers, planners, and administrative personnel. In its study of 10 existing systems N. D. Lea stated, ". . . labor is generally the largest single (operations and maintenance) cost component . . . "~

If an advanced automated guideway system were compared with a modern rail system with the same size vehicles, requirements for maintenance personnel would appear to be similar. Although the automated system might require additional programmers and control room personnel, the large savings in vehicle operators (and stations) should yield it a large labor advantage. However, if the automated vehicle is small and a large number of vehicles are necessary (as with the proposed AGRT vehicle) maintenance requirements could be considerably larger than for a conventional system. When an automated system is compared with a bus system of comparable size, the labor tradeoff is in the number of bus operators versus the number of persons required to maintain vehicles and guideways. OTA has found no definitive studies on this issue and finds that further study is necessary.

Labor skill mix

Many of the jobs in a bus operation are regarded as "unskilled' '-drivers, cleaners, and many of the shop functions. Were an automated system to replace all or a portion of a bus fleet, it is possible that many of these unskilled jobs would disappear. While a few more highly trained technicians would be required for vehicle and system maintenance, the required skill mix for new systems is not well-understood.

Timing of labor impacts

UMTA's scenario for automated guideway systems envisions small deployments in a few cities beginning with the DPM demonstrations. "Advanced" technologies would then be implemented starting in the late-1980's. If current capital funding policies are followed, these advanced systems would be implemented in "oper-

*N. D. Lea & Associates, Inc., *Summary of Capital and Operations and Maintenance Cost Experience of Automated Guideway Transit Systems*, June 1978, p. 16.

able segments. "[9] Under such circumstances it is unlikely that any single urban area could have a substantial automated guideway network in operation before the mid-1990's. At that time societal attitudes toward the substitution of automation may have changed. In any case the rate of implementation would be gradual and existing Federal law would ensure that no existing employees were displaced. [10] Provisions of existing labor agreements also need review and revision where necessary to be consonant with the nature of AGRT operations.

[9] U.S. Department of Transportation, Urban Mass Transportation Administration, "Major Urban Mass Transportation Investments: Statement of Policy," *Federal Register* 41 (Sept. 22, 1976).
[10] *Urban Mass Transportation Act of 1964*, sec. 13(c).41513.

Although it has been argued that AGRT would be more labor-productive than other transit modes, supporting data are not available. However, labor relations and the potential reduction of unskilled labor positions are important social issues deserving serious consideration by UMTA.

Unresolved issues:

- the size and nature of the labor force required for advanced AGT systems,
- the impact of existing labor agreements on the deployment of regional automated systems, and
- social impacts from the potential reduction in transit jobs for unskilled persons.

Summary

AGRT possesses several inherent advantages which give it great potential as an urban transit mode:

- a less costly guideway that allows coverage to be increased (beyond that of conventional designs) for each dollar invested,
- a guaranteed seat,
- station-to-station service without the necessit y to transfer, and
- a high level of service at all times of day.

These characteristics can be provided on any mode. However, i t is the technological advances of AGRT that make them more economically feasible. In addition, the lighter less-obtrusive guideway should make AGRT more esthetically acceptable to the community.

Although AGRT appears to be a strong candidate in local alternatives analysis, its suitability will largely be determined by local site-specific conditions. The purpose of UMTA's AGRT program is not to develop a universally best-suited mode, but to make available to cities a new set of options, which, with adequate funding, will be preferred in many applications.

The most serious deficiency of AGRT planning is a satisfactory procedure for evacuating passengers in a hurry. The best approach is to design in such a way as to minimize the number of instances in which evacuation is required. Failure to resolve this issue will severely limit the range of opportunities for AGRT deployment. Two other areas need more serious considerations by UMTA: labor issues and the system optimization studies.