

A Position Paper

THE

URBAN MASS TRANSPORTATION ADMINISTRATION'S

PROGRAM OF DEVELOPMENT AND DEPLOYMENT

OF

AUTOMATED GUIDEWAY TRANSIT

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INTRODUCTION

Several private initiatives to develop automated guideway transit (AGT) systems began to appear in the United States in the early 1960's. The motivation then was--and still is--the judgment that these "AGT" systems could provide a substantially higher level of urban transportation service for substantially lower cost. There was naturally much disagreement over the specific features of these systems, and of course, many people doubted that they would ever provide a significant contribution to public transit.

In 1966, Congress formed the Urban Mass Transportation Administration and gave it responsibility for development of new types of transit systems. But the vast majority of UMTA's activity was pointed toward distribution of federal transit funds to existing transit systems to prevent their continued decline. Most of the professionals in the transit community were understandably so busy with problems of operating, expanding or deploying conventional systems that they had little or no patience with new systems and new service concepts. As it had been decades since any new type of transit system had been deployed, few people within the industry thought at all in terms of development or deployment of new systems. There was no institutional structure related to new systems, there was no consensus that adequate transit service could not be provided by expanding and up-dating existing systems, and the increasing subsidies removed incentives for fundamental change. Nevertheless, an influential group of people felt that transit suppliers could do most of the necessary research and development on existing systems and that it was the government's business to get on with the task of development of new systems.

In the early 1970's, the "new-system" view seemed to some extent to prevail in UMTA's Office of Research and Development, but there was no real

system view either in terms of the level of service that ought to be provided or in terms of optimization of the physical hardware needed to reach a particular service level. In late 1970, in response to political pressure from West Virginia, UMTA let contracts for construction of the Morgantown AGT system. In 1971, they funded four companies \$1.5 million each to set up AGT demonstrations at Transpo '72, Dulles International Airport, in hopes that that would stimulate cities to procure systems. In these actions, no patience with systems analysis was apparent. Things had to be built right away.

The results of Transpo '72 were disappointing. About 18 months later, Las Vegas announced that they had selected the Rohr Monocab AGT system, but the order did not materialize. While a few systems were ordered for airports and zoos, no urban area ordered an AGT system. Pressure increased for UMTA to stimulate the market, and in mid 1975 UMTA announced the Downtown People Mover Program. (DPM was a new name for the simplest types of AGT.) Cleveland, St. Paul, Los Angeles and Houston were selected for deployments in late 1976. But in 1977 the new Cleveland mayor refused the DPM funds, saying the system would be too expensive and too disruptive; and, in May 1979, the Minnesota House of Representatives voted against the St. Paul People Mover. These actions provide motivation for a review of UMTA efforts to develop AGT.

In the following paragraph, the Morgantown program is reviewed. Next, the most advanced UMTA AGT development program is shown to have serious problems, and finally the Downtown People Mover Program is shown to have been flawed from its inception. It is concluded that UMTA initiatives to develop and encourage development of new transit systems are failures. UMTA has neither developed nor absorbed the transit systems theory needed to guide the development of new systems. UMTA has not taken advantage of modern systems development

techniques and procedures. UMTA has not developed a broad concept of transit service toward which new systems development programs can be aimed. Instead of facilitating the process of development of new systems, UMTA has inhibited that process. It is time to reconsider how civil research and development in the national interest should be done. A concept analogous to the agricultural experiment stations is suggested.

THE MORGANTOWN PROGRAM

The contracts for the Morgantown AGT program were awarded in December 1970 and stipulated that the first vehicles had to be running in October 1972. The prime contractor for the system was the Jet Propulsion Laboratory and the vehicles were to be manufactured by Boeing. Neither had had experience in the field of AGT. By contrast, it takes approximately seven years for a new airplane design to move from concept to flight test in companies in which there are experts in all phases of aeronautical engineering. No comparable theoretical or experimental background was available to guide the development of the Morgantown AGT system. The result was a system substantially overdesigned from the original concept of the Alden Starrcar System upon which it was based. The totally unrealistic 20-month development schedule led to a four-to-one cost overrun, thus producing a great deal of disillusionment with the whole field of AGT.

People in positions of influence, but with little knowledge of the details of the Morgantown Program, became convinced that the failure of Morgantown was somehow a failure of automation, a failure of modern technology. It became conventional wisdom that the answer was to move toward simpler systems in future deployments. But the best of modern technology never had a chance. The failure of Morgantown was not the failure of technical sophistication but the failure

to understand the process of development of new systems. Instead of funding Morgantown, UMTA should have proposed a ten-year development program with all the required phases: systems and planning analysis, economic analysis, trade-off development and analysis, component design and testing, subsystem testing, more analysis, full-scale system testing and public demonstration, thorough socio-economic assessment, and only then, deployment in a city. Ample time should have been scheduled for possible changes in direction as a result of unforeseen findings. But there was no commitment to such a process. The pressures to deploy an existing but under-developed system were too strong. Perhaps landing of men on the moon made people overconfident and impatient. Whatever the reason, we have suffered for it. The Morgantown program did little to advance transit technology.

THE ADVANCED GROUP RAPID TRANSIT PROGRAM

The AGRT Program is UMTA's most advanced initiative in the AGT field. It may be thought to be a long-term system program of the type described above. Unfortunately, it is not. The reasons are: 1) that it is based upon system configurations (one an advanced version of Morgantown) that were settled upon long ago without the detailed systems analysis needed to determine optimum configurations; and 2) that basic system parameters (headway and vehicle size) were given in advance rather than as variables to be determined by analysis.

Three illustrations of the difficulties will suffice:

1) The vehicle size of 12 seated passengers was chosen together with off-line stations and networks of upwards of 200 stations without the benefit of detailed operational simulations. Subsequent simulations of similar configurations performed in the Colorado Regional Transportation District's large-scale study of transit alternatives produced the following result¹:

"The overall conclusion is that either an on-line, all-stop system, or an HCPRT (high-capacity personal rapid transit) system with nonstop, single-party, origin-to-destination service are promising alternatives, whereas the intermediate headway systems (including GRT) offer little, if any, improvement in service over a simple on-line, all-stop system. A system such as the high-performance PRT (now AGRT) with 12-passenger vehicles might be desirable, if operated as an HCPRT during the off-peak, and used to provide multi-party, nonstop, origin-to-destination (or origin-to-transfer station) service during the peak periods."

Unfortunately the waiting time for the latter type of group service concept quickly becomes too long to be practical as the system grows. The problem became apparent when the vehicle and passenger flows through stations were simulated. The above results mean that AGRT may not be a workable concept, except in systems with very few stations, and at best, the concept is not operationally efficient. This result has been available since early 1975 and is known to some UMTA people. Unfortunately, by picking the vehicle size in advance they locked themselves into an ineffective configuration, but to change it would require major redirection of the whole program. Because of Morgantown, it may have been felt that Congress would not tolerate a new major blunder. Thus, the AGRT program goes on, perhaps with the hope that the internal contradiction will be resolved later.

2) The guideways of the principal configurations are wide U-shaped troughs with the power rails attached to one side. Figure 2.2 from Report No. DOT-TSC-OST-77-54 (included with this paper) shows that UMTA views this configuration as the only one worth considering. Yet, UMTA's own research² shows that the U-shaped trough configuration has had serious and possible insurmountable winter weather problems. That this should be the case is immediately obvious to many people who live in northern climates. Snow must be melted from the whole width and length of the guideway by means of energy-consuming heaters imbedded in the concrete, the power rails ice up, and thermal cycling

of the reinforced concrete guideway is likely to produce cracks in the surface and eventually may lead to its disintegration. Moreover, a two-way configuration is 15 or more feet wide, it takes a significant strip of land, it is costly to build into a city streetscape, and it has a large visual impact.

The only substantive justification given for the U-shaped trough guideway is that, in emergencies, it permits people to escape from the vehicles onto the guideway. But considering winter weather, elderly and handicapped people, and exposed high-voltage power rails, such an escape method is inappropriate. There is a better approach to this problem.³ It needs to be examined in a total system context in which probabilities of various failure modes are estimated and potentially serious failures are corrected by redesign. Only then can the most economical and effective escape methods be devised. One, for example, is the use of simple carriages attached to the side of the guideway and normally stored at the stations. All of these matters need to have been considered before selecting the guideway configuration.

3) The operational headway is limited to three seconds. Such a limitation is technically necessary if the vehicles use propulsion and braking through the wheels but not if linear electric propulsion and braking is used. The significance of the limitation on headway is that it provides too severe a limitation on capacity in large systems. If the system were to remain small, comparable to a downtown people mover, there is no problem, but if there is interest in expansion, as there almost always is, it may become capacity limited. By choosing linear electric propulsion and braking, and by choosing one of a number of continuous position sensing systems, an arbitrary headway limitation is avoided, and the system does not have to be rebuilt at great cost if it is expanded. Again, systems analysis shows the advantage of the choice and would have led to a configuration different from those selected

for AGRT. The question of headway is one of the most controversial in AGT development, and can be settled only through understanding of transit systems theory. See References 4 and 5.

The conclusion is that, by use of unsubstantiated intuition in parameter and configuration selection, wrong technical choices are made and the resulting systems will have serious economic, functional and service limitations.

THE DOWNTOWN PEOPLE MOVER PROGRAM

On May 24, 1979, the Minnesota House of Representatives voted 103 to 26 against the St. Paul DPM System, thus denying support for ten percent of the capital costs by the State of Minnesota. Unless a revised proposal can be made for less than half of the projected \$90 million capital cost or another source of funds is found, the project is dead.

The project was defeated in a two-and-one-half hour debate on the floor of the Minnesota House mainly because the line and station configuration was not perceived to provide a significant service. Too many of the trips could be taken by walking, particularly through the skyway system. The comment that the people mover didn't go anywhere was constantly raised. Because of the topography, it could not be well connected to peripheral parking. Unfortunately, the UMTA procurement process required that the approximate route configuration be selected hurriedly during the proposal period (May 1976) before an adequate process of analysis and community involvement could be carried out, and did not permit anything but minor deviations. An important additional factor in the defeat was derived from the data of the Preliminary Engineering (PE) study, and from a Charles River Associates (CRA) review of the PE study for the Twin Cities Metropolitan Council. In a nutshell, the CRA study showed that the present worth of a 40-year stream of benefits calculated was only of the order of \$60 million, whereas similar analysis showed that the

present worth of the operating and maintenance costs over the same period were of the order of \$100 million. Thus the \$18 million local share of the capital cost was only the tip of the iceberg. Moreover, to make the patronage estimate valid, \$60 million worth of fringe parking ramps would have to have been constructed and, according to CRA, these ramps would have operated at an annual deficit of up to \$2 million.

The financial and planning analysis of the St. Paul DPM was based on a so-called "baseline" configuration: a two-way, U-shaped concrete trough guideway configuration 27 feet wide, upon which 33-passenger vehicles moved between on-line stations. Although this was to be a simple configuration, the consultants at one time showed 18 switch crossovers for the purpose of handling failed vehicles. UMTA insisted that the baseline procurement process was necessary in order that none of the so-called "proven" systems would be ruled out of competition. The alternative of a design competition in which suppliers would participate and explain the characteristics of their specific systems was not considered. Much emphasis was placed by UMTA on the idea that the system chosen for deployment would be one that was technically proven, by which they meant that that system had operated in some form in public service. This idea was repeated many times in St. Paul even though UMTA's own report on winter operations² indicated, as mentioned in the above discussion of AGRT, that the suppliers of systems that resembled the baseline configuration were having great difficulties with winter operation. As the St. Paul DPM Task Force became aware of the problem of winter operation, they modified the illustrations used in public information to a narrow guideway system and told people that the baseline system was only the most expensive of a number of alternatives and was chosen to obtain a high estimate of the costs. By the time they realized the difficulty (it should have been clarified to them by UMTA) it was too late

to do anything else. By providing financial and physical data on the "baseline" system only, there was no opportunity to learn if a more cost effective, narrow guideway system, possibly with a different line and station configuration, would have been accepted. An unnecessarily rigid procurement process, the difficulties of which should have been debated, caused a great deal of wasted effort.

The recommendation to Congress to institute the DPM Program developed out of a 1975 study of the Office of Technology Assessment. As a member of the economic panel of that study, this author had no opportunity to debate the concept of the DPM Program. From the economic viewpoint, it could not have been justified. Indeed, the DPM program had been conceived in part as a result of complaints that an UMTA policy, which required that all capital grant applications be preceded by an economic alternatives analysis, prevented new systems from being selected. Instead of resolving to mount a program to develop an AGT system that could win an alternatives analysis, a decision was made as part of the DPM Program to waive the alternatives analysis. It was not difficult in 1975 to show that the type of DPM typified by the baseline configuration would be too expensive. The St. Paul study's ratio of costs to benefits well above one merely provides confirmation of a result of rather simple analysis. The St. Paul system was estimated to cost a little less than \$40 million per two-way mile and the maximum flow past a point computed from the patronage analysis was less than 1500 people per hour. Characteristics like these could have been estimated roughly during the time of inception of the DPM Program and would have contributed to understanding of the economic problem. The fact that they were not considered indicates a profound indifference to the need for economic viability in AGT. Moreover, during the large-scale alternatives analysis conducted in Denver in 1974-1975 citizens groups had completely rejected the wide, two-way, concrete guideway--just the kind of configuration that formed the basis of the

DPM Program. This information, readily available at the time, was ignored. The DPM Program, unfortunately, was from its inception fated to parallel the Morgantown experience. It originated from a desire to build systems as soon as possible, and lacked understanding of the socioeconomic consequences of the technology.

A SEARCH FOR COST EFFECTIVE AND TECHNICALLY SOUND AGT

The question of developing a technically sound AGT system that would provide a substantially higher level of service than possible with conventional transit for minimum cost has occupied the attention of many people during the last quarter century. These efforts have led many inventors independently to some version of the basic concept now referred to as personal rapid transit. Unfortunately, the term personal rapid transit (PRT) is used to describe the Morgantown system and other non-optimum configurations thus rendering it all but useless without modifiers. The original concept is, therefore, often referred to as "true PRT" or, as mentioned on page 5, HCPRT. The latter designation was used to describe an UMTA "true PRT" program that was cancelled in August 1974. The HCPRT program had received an appropriation from Congress in 1973 and the detailed request for proposals had been prepared. At the time of cancellation and diversion of the funds, no hearings of any kind were held. Nonetheless, UMTA now has documented information on two true PRT systems, The Aerospace Corporation system⁶ and the German Cabintaxi system.⁷ The Aerospace Corporation system is also now described in a book⁴ and many other forms of PRT as well as planning for them are described in the series of books PRT⁸, PRT II⁹ and PRT III.¹⁰

By analysis of the work of many investigators, it is possible to set down some basic concepts of cost-effective AGT. By "cost-effective AGT" is meant

AGT systems in which the ratio of annualized capital cost plus annual operating and maintenance costs to annual patronage, i.e., the total cost per trip is minimum. The author has developed concepts of cost-effective AGT in Transit Systems Theory⁵ and in summary form in a slide presentation.¹¹ The results are obtained by seeking step by step to minimize total system cost. They are summarized as follows:

1) The most expensive element of an AGT system is the guideway and its support structure. Three basic factors determine its capital and operating cost: the shape of the cross section, the weight per unit length of the vehicles, and the provision or lack of provision for standing passengers. Analysis of bending, torsional and vibratory loading leads to an understanding of these factors. The optimum cross section is a deep, narrow beam with a width roughly one third the depth. The vehicles must therefore be designed to fit the guideway and not vice versa. The required guideway weight per unit length needed to support the vehicles is directly proportional to the vehicle weight per unit length. The vehicle weight per unit length is minimized if small vehicles permitting only seated passengers are used. Minimizing guideway and vehicle weight per unit length minimizes the size and cost of the support structures, minimizes right-of-way requirements, makes possible prefabrication and quick erection of the guideway, and minimizes vibrations associated with vehicles entering buildings. The resultant narrow guideway minimizes costs of winter operations and visual impact. Proper selection of the configuration can eliminate the need for guideway heating.

2) Regardless of vehicle capacity, the cost of the entire fleet of vehicles is minimized if the average trip time is minimized. The trip time is minimized if every trip is on-demand and nonstop so that vehicles wait at stations a minimum of time and do not make intermediate stops, and if the passengers are seated

so that comfortable speed changes occur as rapidly as possible. But, on-demand, nonstop service can be provided only if small vehicles are used. Thus, it is seen that the use of small vehicles leads to minimization of both the fleet cost and the guideway cost. On-demand, nonstop service is possible only if the stations are off line. But, with small vehicles, off-line stations are necessary if the capacity is to be adequate. Fortunately, if narrow guideways are used, the cost of off-line stations is less than the cost of the much longer and larger stations required with on-line-station systems. The surprising result is that cost minimization leads to the best service that can be provided--nonstop, on-demand service with a seat; and, with such service, a passenger travels with others by choice, not by necessity. A further advantage of a minimum-cost system is that, for a given cost, the service area covered is maximized.

3) If linear electric motors are used for propulsion and braking, adequate capacity can be maintained in all weather conditions because the coefficient of friction of the track does not affect propulsion and braking, and because the response time of braking can be made sufficiently short to not restrict capacity. On the other hand, if rotary motors and wheel brakes are used, larger vehicles are required for a given capacity because close spacing between vehicles cannot be maintained in all weather conditions. Hence the costs increase and the service deteriorates.

4) Power rails must be covered to minimize problems of ice formation and consequent service disruptions during severe winter weather.

5) To provide adequate service availability to the public, all critical on-board subsystems such as motors, controllers and brakes must be redundant and failure monitored, and a control strategy must be developed to permit rapid removal of failed vehicles.

6) Switching must be accomplished using mechanical moving parts in the vehicle only and not in the track. Moving track switch parts do not respond rapidly enough to remove headway limitations and require extremely high reliability. The consequent longer headway means larger vehicles for given capacity, higher guideway cost, and poorer service.

7) Controllers must be designed to sense continuously the position of the vehicle ahead regardless of its operating condition. Such controllers permit safe operation at minimum headway. Therefore, they permit the use of vehicles of minimum size and hence, minimize system cost.

8) The vehicles must be designed to protect the passengers in the unlikely event of a collision. This is possible with small, personal vehicles because of their low kinetic energy, but not with large vehicles.

9) Strategies for rescuing passengers from non-movable failed vehicles must be developed in a manner other than requiring passengers to walk on the guideway. Such a development requires understanding of the probabilities of various kinds of failures.

By careful selection of line and station locations, an AGT system designed according to the above principles operates in a cost effective manner in a small loop, in a large network, or in intermediate configurations. In small loops, however, the advantage of the off-line station is minimal but increases with system size. Likewise, in a small system, say with fewer than a dozen stations, the advantage of nonstop, on-demand service is operationally minimal but increases with system size. But, by beginning with optimal subsystems, the guideways and stations fit much more easily into the city and the network can be expanded to provide additional service without modification of the guideways or vehicles. The line configurations could be similar to

those used with rail transit systems but, because of substantially lower unit costs, need not be so restricted. It is often stated that true PRT systems are effective only in large, city-wide networks. While large networks become practical and provide much better transit service, they are by no means necessary for cost effectiveness.

Energy use is minimized with a cost-optimal system. Construction energy is minimized because both guideway and vehicle-fleet weight are minimized. Operational energy is minimized because the use of on-demand, nonstop service permits satisfaction of a given demand with minimum vehicle movement. For the same reasons, operational costs are minimized.

Service in a cost-optimal AGT system is nonstop, on-demand (short wait in the rush period) at all hours, private with one's own traveling companions and not with strangers, and permits seating of all passengers. Wheel chairs and luggage can be accommodated. It is remarkable that such service--the best that can be provided--is not a luxury, but must be provided to minimize capital and operating costs. This is perhaps one of the features of "true PRT" most difficult to understand. One expects that economy implies discomfort. Surprisingly, mass movement of people in cities is markedly more expensive. Personal service permits use of a much lower cost guideway structure which permits the construction of many more stations for a given cost. (Compared with conventional rail, The Aerospace Corporation found that roughly twenty times as many stations can be included for a given cost.⁴) The service implications of use of cost optimal systems is therefore considerable.

Many transit analysts have difficulty understanding why the operating and maintenance costs will not be much higher with many small vehicles rather than a few large ones. One answer is to examine the detailed cost information

provided in References 4, 6 and 7. Another answer is to note: 1) that with a larger number of smaller vehicles, maintenance operations can be more easily routinized and automated, and 2) that large vehicles are more difficult and expensive to handle than small vehicles. But intuition provides only a little help, one must examine the data.

A common question about the small-vehicle system relates to complexity: With all the problems seen in development of larger vehicle systems, will not the problems multiply with development of smaller, more sophisticated vehicle systems? If the cost-optimal system is developed in the manner of the Morgantown system, the answer certainly is yes. There is no question that development of a cost-optimal system requires excellent engineering and excellent management, and it must be preceded by understanding of basic transit systems theory. Without proper theoretical understanding, choices will appear to be based on subjective preference rather than on analysis. In this circumstance, an engineering team will be reduced to arguing over every point. The layman has difficulty understanding the importance of proper training of engineers placed in a specific task. For a specialized task such as discussed here, engineers need more knowledge than is obtained in a typical engineering curriculum. Without such additional knowledge, costly errors are inevitable. A small-vehicle system must be cleanly designed if it is to minimize cost. It must be subject to detailed failure modes and effects analysis early in the design program, and it must be designed to be fault tolerant. The program must not be subject to unrealistic time schedules. Only then can the resulting system provide genuinely improved public service.

Except for a brief period in 1973, there has never been an opportunity except in a most perfunctory way to engage UMTA in point/counterpoint discussion

on the characteristics of true PRT. UMTA has never sponsored planning studies in which true PRT could be compared with conventional or large-vehicle AGT systems. Thus, statements UMTA makes concerning comparison of true PRT with other modes are based on unsupported intuition and not upon analysis. Consider this illustration: In the fall of 1978, during an UMTA-sponsored study of socio-economics of AGT, a study team visited Atlanta to obtain citizen information on various AGT systems, allegedly including PRT. They showed the citizen groups pictures of four-to-ten passenger automated vehicles and asked if they would ride them. The answer was that they would prefer larger vehicles because they would feel more secure. Nothing at all was said about the concept of private-party service. On this basis, the PRT option was recommended to be dropped from the study. This is typical of attempts to discredit the concept of true PRT. The concept is assigned characteristics it does not possess (in this case riding with strangers) and it is dismissed on the basis of those bogus characteristics. UMTA could clear the air a great deal simply by revealing the basis of its statements about the true PRT concept and permitting these statements to be commented upon by people who understand the concept. Many of UMTA's objections may be based on genuine misunderstandings.

Urging that the concept of true PRT be given a hearing has often produced the response that the advocates of such a hearing want everything else stopped and converted to work on true PRT. This is another of many exaggerations that have been made. Of course, work on other systems must continue, but there is a great deal of evidence that true PRT ought to be placed on the agenda. More fundamentally, what ought to be considered is the search for cost and energy optimal AGT systems. There is much evidence that that search has led to the form of true PRT described above. But all of the features of an optimal system

cannot be verified without the detailed analysis and experimentation that seems now to be fundable only through governments. If true PRT were to be accepted more and more widely in an open society, it could be accepted only if it were indeed superior to other alternatives. The public will benefit from an opportunity to find that out.

THE GERMAN EXPERIENCE IN AGT DEVELOPMENT

West Germany has a cabinet-level ministry devoted to research and technology development. They are sponsoring development of three AGT systems as well as a high-speed, intercity, magnetically levitated transport system. All of these programs are long range and contain all of the steps of analysis and experimentation needed to create significant advances in the state of the art. There is no rush to deploy systems before they are ready or without thorough socio-economic analysis. One of these systems, C-Bahn, is in its ninth year of development. A loop C-Bahn system is to be constructed in Hamburg beginning in 1980. The next system, H-Bahn, is in full-scale testing in Erlangen and will probably be deployed in Erlangen; and the newest, M-Bahn, is to be built into the Hanover exhibition grounds in the near future. All of these systems will provide remarkable improvements in both cost and service over the baseline type of system described above in the discussion of the DPM Program. From many conversations with German engineers working on new and conventional transit technology over the past eight years, it is very apparent to this author that the above programs would not have been possible without the support of a ministry devoted to research and development in the national interest.

THE INSTITUTIONAL STRUCTURE OF TRANSIT RESEARCH

Trying to get an institution to do something it does not want to do is not productive. It is rather more productive to examine the institutional and

decision-making structure in transit research in the United States to see if it can be improved. The results may also apply to other areas of civil research and development.

UMTA policies have been a failure not only in development of AGT but in development of Transbus.¹² Why? Is it possible for the government to lead development of innovations, or can the government only follow and regulate what exists? In military technology, the government is the buyer and the fear that the enemy will develop a superior technology is always a driving force to continual technology development and improvement. In civil technology the corresponding driving force is the market place; and for government it is, at least in word, the improvement of the public welfare. The microelectronics industry is a prime example of how civil technology works when there is little government interference. Unfortunately, it is difficult to motivate government bureaucracies along similar lines. Indeed, if AGT became too inexpensive, there would be no need of government financing of capital grants at all--government would work itself out of a job. An example of lack of concern for economics is found in UMTA's insistence on wide guideways apparently mainly because of the requirement for escape from failed vehicles. No effort to solve this problem in a cost-effective way through comprehensive systems analysis has been evident. Lacking the incentive of profits, government imposes a design configuration based on simplistic intuitive processes rather than on detailed analysis.

There is a great deal of technical talent in the United States. Our country has traditionally been a land of "Yankee ingenuity" where private inventors develop and market ideas based on resources they can obtain. Perhaps because of dominance of the automobile, transit systems development has apparently gone beyond the stage in which it can be financed privately. But, running counter to the trend, Walt Disney Corporation and Universal Mobility, Inc. both construct

transit systems under private financing, albeit for special circumstances, and PRT Systems, Inc. seems about to do so too, all for substantially less per mile than UMTA-backed systems. Is there not strength through this kind of diversity? Is it not better to let the best ideas emerge in free competition? Instead of performing all physical and financial planning on a single "baseline" system and then requiring that a decision be made on the basis of that limited information, would it not have been better to expose decision makers directly to independently developed plans of a variety of suppliers?

Use of the concept of government financing of new transit alternatives through an agency primarily devoted to other matters has been a failure. The effort has been much more inhibiting than facilitating. UMTA was established in a period in which the standard solution to every public problem seemed to be a new government agency. Many people are beginning to doubt the wisdom of such a practice. Many people are beginning to think that government bureaucracies have become too large, too numerous and too ineffective. To government bureaucrats looking at problems in urban transit in 235 cities, these problems must appear staggeringly difficult--they are difficult enough in one city. To cope, bureaucrats may have to oversimplify. Government bureaucrats are usually influenced most by people they see the most. Being human, they may begin to think that the general public consensus is the consensus of the people they see. But nothing could be farther from the truth. As in St. Paul, the public sentiment rises up only when necessary to kill an illfounded proposal.

Certainly, industries need to be regulated. Technologies can no longer be developed without regard to unintended and negative side effects. The Office of Technology Assessment and other means for technology assessment are absolutely necessary in the complex, interrelated world in which we live. But just as it

is essential to assess, regulate and possibly restrict the development of technologies, it is equally important to innovate in constructive directions in many civil areas. Regulators do not tend to be innovators nor innovators regulators, and when the job of innovation is given to a primarily regulating agency one can be quite certain that few if any innovations will result. If UMTA had been established when stagecoaches were dominant, the history of recent years would suggest that the lobbying efforts of then dominant stagecoach manufacturers and operators would have been able to prevent anything but improvements in stagecoaches. Now when large-vehicle transit is dominant, it is perhaps not surprising that an innovation as different as the concept described in the previous section is strongly resisted. Yet, such an innovation is needed. The problems of innovation in public transit are developed in depth by Dr. C. G. Burke in a forthcoming book (Lexington Books, 1979).

AN ALTERNATIVE

If the UMTA research, development and deployment office did not exist during the past decade, one can scarcely imagine that the AGT development situation would be worse. The hope of federal grants has dampened private initiative. Where federal grants have been forthcoming, they have been for systems far too expensive to fund privately or by municipalities. Instead of encouraging development of the fundamentals of new systems, UMTA has tended to inhibit consideration of anything but certain existing systems.

An ideal would seem perhaps to be a mechanism for public support of research and development through a number of independent agencies, say engineering experiment stations analogous to the agricultural experiment stations. Each of these stations would receive block grants from the federal government, and each would be totally independent of the others. Development of technology in universities would be done cooperatively with industry to make it relevant, and

the industries involved would have to contribute, say, 20 percent of the costs so that they would be motivated to work only on potentially profitable projects. As a consequence, the present detailed federal monitoring would not be necessary to assure that the funds were wisely spent. No central federal agency would be authorized to approve specific projects, but the experiment stations would be subject to federal audit of finances and operations. Regulatory agencies such as safety agencies would be invited to comment on specific designs but would not be authorized to approve designs until they had to be certified for use. Technology assessments would be made by independent organizations, but the experiment stations would have resources needed to challenge the findings.

The need for innovations in civil technology is too urgent to drift along present paths. Frank, open discussion of failures and potentialities is badly needed.

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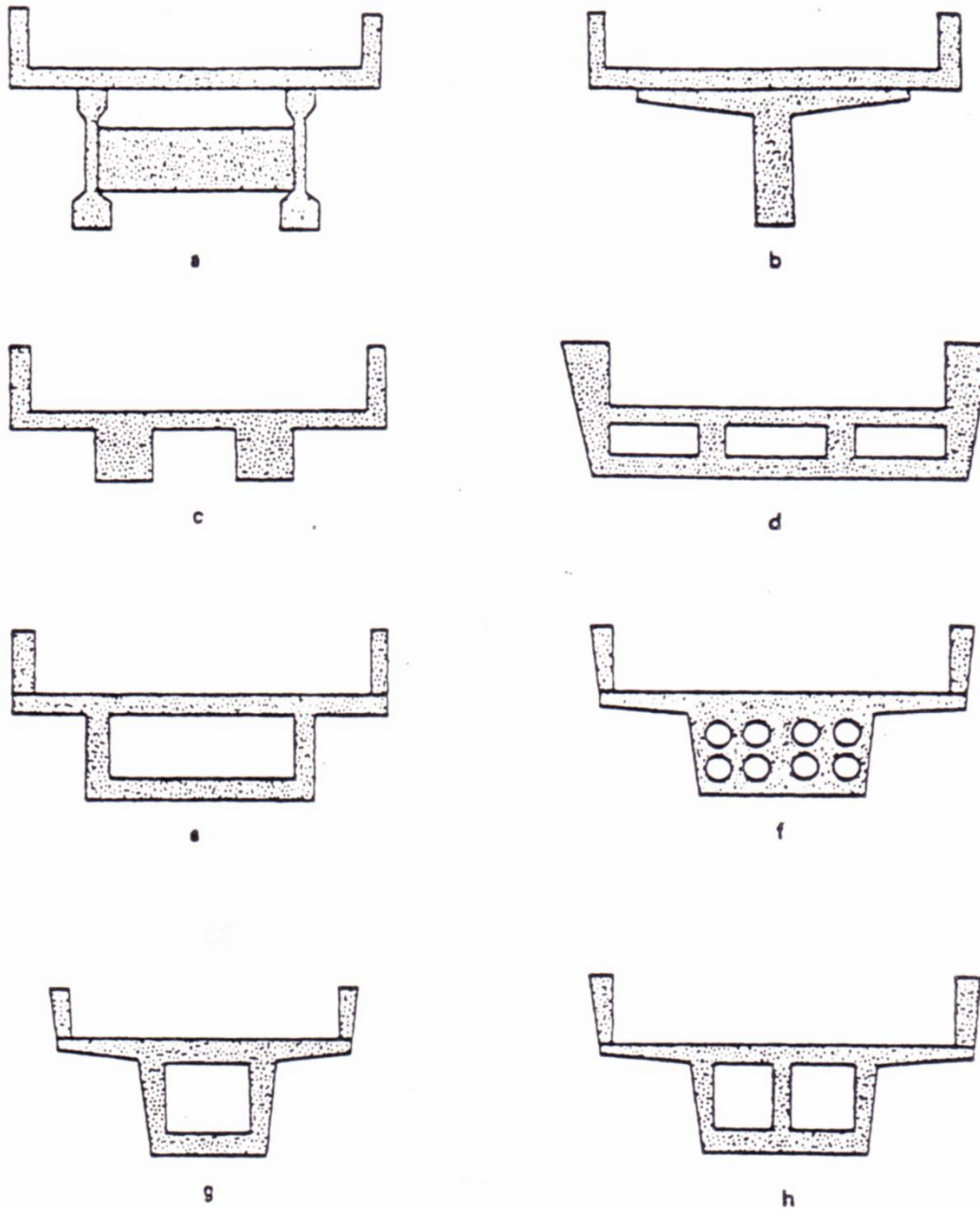


FIGURE 2.2: SUPERSTRUCTURE GUIDEWAY CONFIGURATIONS

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(From Report No. DOT-TSC-OST-77-54, Elevated Guideway Cost-Ride Quality Studies for Group Rapid Transit Systems.)