

# Status and Prospects of the Automated Guideway Transit Industry in the United States

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## ABSTRACT

Since the late 1970s, many changes have taken place in the firms that are active in providing automated guideway transit (AGT) systems. Many U.S. firms once active in the industry have withdrawn, and at the same time a number of foreign firms have demonstrated that they can compete effectively within the United States. Recent history of the U.S. portion of the industry is reviewed and interpreted in the light of the nature of the AGT market; the types of firms that were at one time in the industry as well as those that remain; and the dynamics of entry and exit in the industry. Based on this background, the future prospects for the industry are discussed. The importance of the role of the federal government, and as a result, the existence of two AGT markets--federal and nonfederal--is emphasized. The primary focus is on the federal AGT market, and the following implications of both U.S. and foreign governmental roles for U.S. firms are explored: high business development costs, frequent lapses in program continuity, high levels of dependence on local decision making in spite of federal funding for system planning and implementation, and disparities in levels of support for AGT research and development from country to country.

The present status of the United States automated guideway transit (AGT) industry depends strongly on a history of activities that goes back at least a quarter century, when General Motors was conducting in-house research on automated highways and a number of other firms were beginning to think about systems involving driverless vehicles on separate guideways. As shown in Figure 1, at least six of these firms had committed significant resources to AGT by 1965 and two firms--General Motors and Westinghouse--were operating test or demonstration systems. By 1970 the number of firms had almost doubled and three systems were in regular use at recreation centers--Disneyland in California, Sacramento's California Exposition, and Hershey Park in Pennsylvania.

As shown in Figure 2, federal involvement in supporting AGT systems began in a significant way in 1963, when UMTA's predecessor agency provided a grant to Westinghouse to assist in the construction of the South Park test facility in Pennsylvania. Soon thereafter, this agency, now within the U.S. Department of Housing and Urban Development (HUD), funded a series of studies, culminating in the report entitled *Tomorrow's Transportation, New Systems for the Urban Future* (1), which was submitted by President Johnson to Congress in 1968. This report contained conceptual studies of a number of automated passenger systems and provided significant

impetus to both industry and government throughout the 1970s.

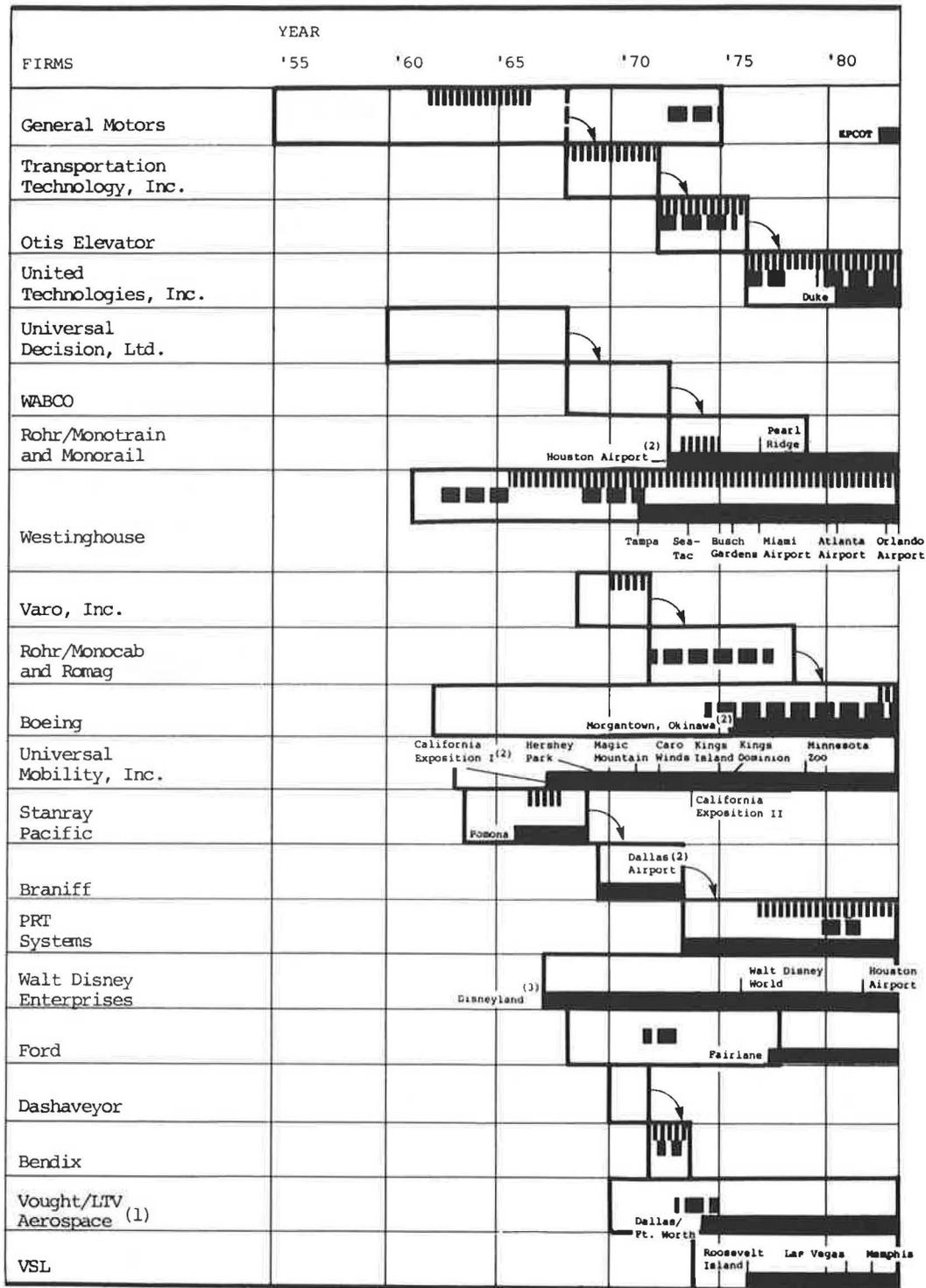
Since the establishment of UMTA within the new U.S. Department of Transportation (DOT) in 1968, UMTA's role in supporting advanced technologies has focused on three major activities: research and development (R&D), demonstration, and implementation. The R&D component has emphasized advanced systems design and testing, including the dual mode feasibility studies carried out between 1973 and 1975 and what began as the High Performance Personal Rapid Transit (HPPRT) program in 1974. Preliminary studies of dual mode transit system feasibility were carried out by General Motors, Otis, and Rohr. Each proposed to continue development of systems that would be under driver control for passenger pickup and distribution functions and under automated guideway control for the line-haul portion of their routes. Because of a lack of DOT funds, however, the dual mode program was halted at the conclusion of the preliminary studies.

In the HPPRT program, later renamed Advanced Group Rapid Transit (AGRT), three firms (Boeing, Otis, and Rohr) were funded, beginning in 1974, to develop a third generation of automated systems that would go beyond the sophistication and flexibility of the existing systems. This program has continued, with some significant funding gaps and changes in focus, to the present. Test track experimentation by the two firms remaining in the program (Rohr discontinued its involvement both in the AGRT program and in automated systems development in 1978) is currently funded through 1984; however, the emphasis is now placed on advanced control subsystems rather than on complete vehicle-control guideway systems.

UMTA's involvement in programs structured to demonstrate AGT systems in various environments began with its funding of TRANSPO '72, an exhibition of America's transportation capabilities held at Washington's Dulles International Airport. In the AGT area, funds were provided to four firms (Bendix, Ford, Otis, and Rohr) to implement systems that operated during the exhibition and to continue their testing after it closed.

A much more ambitious demonstration program began in 1975, when U.S. cities were invited to submit proposals for Downtown People Mover systems, which would demonstrate available AGT systems in dense urban environments. In 1976 six cities were authorized to carry out system planning activities. Cleveland, Houston, Los Angeles, and St. Paul also received promise of new construction funds if the planning results showed automated circulators to be warranted. Detroit and Miami were encouraged to use previously committed fixed guideway funding from UMTA for DPMS.

As local planning activities were carried out, three cities--Cleveland, Houston, and St. Paul--decided not to continue in the program. In 1981 when the DPM program was suspended by UMTA, Los Angeles halted the planning for its system. Partially because both Detroit and Miami were not dependent on commitments originating in the DPM program and partially because of strong congressional support, they were able to proceed toward system implementation.



(1) Inactive since 1980. Has not withdrawn.  
 (2) Subsequently removed from service.  
 (3) Not completely automated.

**KEY**

- ██████████ Test track in operation
- ██████████ UMTA-funded R&D and/or demonstration
- ← Start-up dates
- ██████████ AGT system(s) in regular operation
- Overall period of activity in the AGT industry
- Sale or other transfer of AGT activities from one firm to another

FIGURE 1 Summary of major involvements by U.S. firms in the AGT industry.

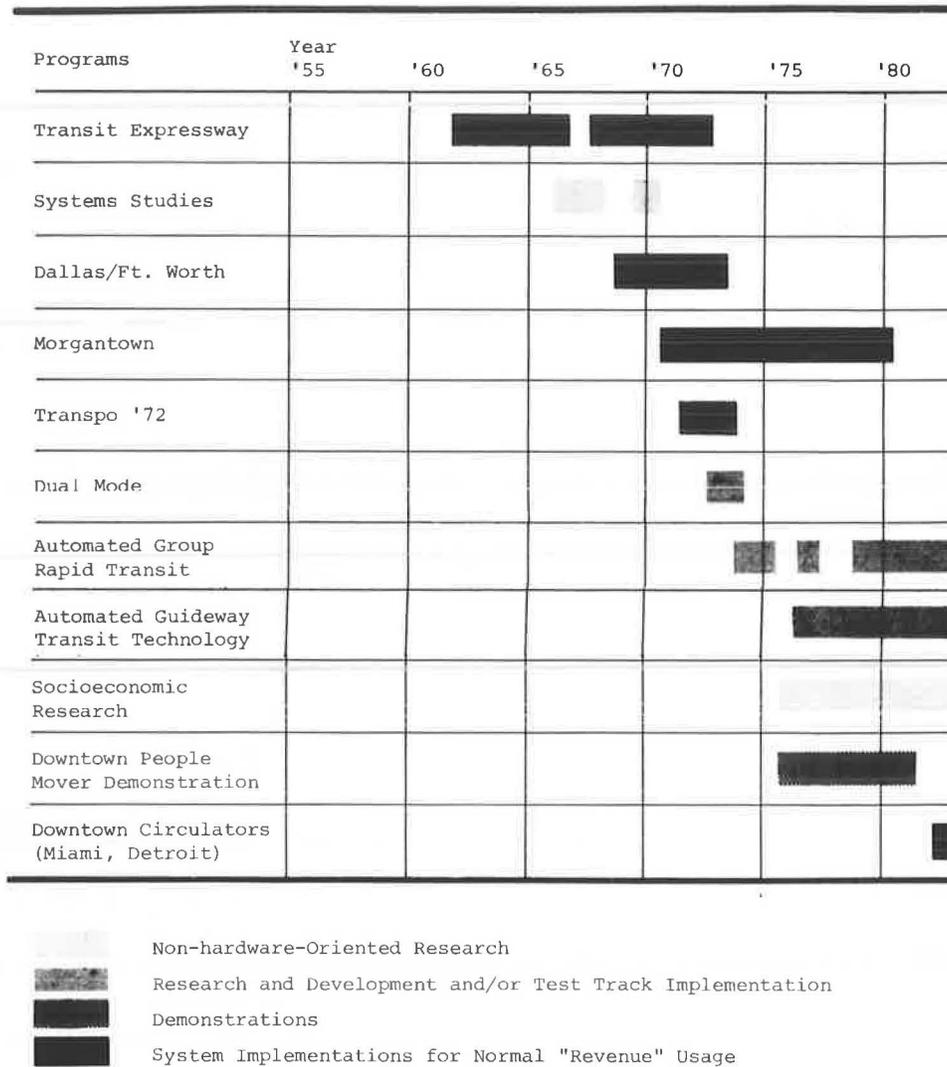


FIGURE 2 Summary of major HUD and UMTA AGT programs.

These cities have selected UTDC (a Canadian firm) and Westinghouse as their system suppliers and have proceeded with final engineering and construction activities. Thus what began as the DPM Demonstration Program is continuing as an UMTA-funded automated system implementation activity in both Detroit and Miami.

UMTA's previous involvement in AGT implementation activities was mainly through its support of the Dallas-Fort Worth Airport system (AIRTRANS, developed by LTV Aerospace) and the Morgantown PRT system for which Boeing had system management responsibilities. Construction of both systems began in 1970; UMTA's role was quite small in the AIRTRANS system implementation effort, but UMTA was the major funding source for the Morgantown system.

UMTA's major support of AGT activities since 1970 has not been the only impetus to progress in this technological area. During the same period significant progress has been made in implementing systems in restricted environments such as airports, recreation centers, and other private high-activity locations. As of 1983 there were at least 25 systems in normal operation, and additional ones are being built. At least five others were built but never placed in normal service, replaced by more advanced systems, or otherwise removed from service. The num-

ber of firms continuing to offer such systems, however, has declined significantly.

Three firms--Disney, Universal Mobility, Inc. (UMI), and VSL--continue to offer airport or recreation center systems, but only one U.S. firm, Westinghouse, is now actively involved in supplying systems for public transportation services. (UTDC, a Canadian firm, is currently the only foreign firm that has sold a system in the United States--the Detroit People Mover. Thus UTDC has been included in this survey of firms involved in the U.S. AGT market. A number of other foreign firms also have an interest in the U.S. market but have not been considered in this analysis except as potential competitors to the U.S. firms.)

Two firms--Boeing and Otis--continue to be involved in AGT research and development. Both have plans for future marketing of the control subsystems they are now beginning to test under more realistic conditions than the laboratory tests to date have allowed. Two other firms retain marginal levels of AGT market activity--Budd as a marketer for the foreign manufacturer of a magnetic levitation system and LTV, which retains the option to become active again if future market conditions warrant.

This settling out of the AGT supplier market is a phenomenon common to many technological areas (for

example, automobile manufacturers in the period from 1920 to the present), but it has been highly dramatized by the speed of the process for AGT. Two other factors have further highlighted this rapid narrowing of the number of suppliers:

1. The federal government, through UMTA, has invested a significant amount of money--more than \$200 million--in AGT-related research, demonstration, and implementation. One explicit goal of this funding has been to support enough firms to allow a competitive AGT market to exist.

2. Foreign suppliers in France, Germany, Japan, and Canada have taken the lead in implementing AGT systems to the extent that they are now often considered to have a competitive advantage over U.S. firms in spite of the "Buy America" restrictions imposed on UMTA-funded procurements. In some instances, U.S. firms have obtained licenses to market foreign systems in this country.

The purpose of this paper is to provide information required to understand why these rapid changes have occurred in the U.S. AGT industry and where the industry is likely to go in the near future. The focus is on the industry as it is viewed by the suppliers themselves; these views were obtained from both published materials and personal interviews with representatives of nine of the past, present, and potential suppliers. The material here has been drawn from a report to UMTA (2), which also includes summaries of these personal interviews.

This study also draws on, and provides an update for, two previous studies prepared by the Office of Technology Assessment in 1975 and 1979 (3,4). The analysis is based heavily on events since 1978, especially as these have been influenced by activities of the DPM Demonstration Program and the AGRT program. The DPM program reached its peak of activity, from the system suppliers' viewpoint, in 1980 just before the end of the program in early 1981. The AGRT program has continued since 1975 but has experienced a number of slowdowns and redirected activities.

The remainder of this paper is organized into four sections: the nature of the AGT market; the types of industries likely to become involved in the public AGT market; the dynamics of entry to and exit from the AGT industry; and prospects for the future of the industry.

#### THE NATURE OF THE AGT MARKET

Even at the peak of involvement by U.S. firms in AGT, only about 12 producers were active. To date, buyers and potential buyers are similarly limited--a few airport authorities, recreational park developers, and cities or transit agencies. Furthermore, when the AGT products available from the U.S. firms are carefully classified, it becomes clear that there are really two AGT markets--one in which DOT is not involved directly and one in which it has been the primary system buyer, either directly or by providing the funds to be used by other entities to purchase systems.

The first AGT market may be termed the nonfederal market; it is represented by all but one of the AGT systems now operating in the United States--those at airports, hotels, shopping and medical center complexes, and amusement and recreational parks. With two exceptions (Westinghouse and Otis), the suppliers of these systems have not been involved in both the first and second AGT markets. None of the firms involved solely in the nonfederal

market--UMI, VSL, and Walt Disney Enterprises--appear to be interested in the second AGT market. None chose to bid to provide the DPM systems in Los Angeles, Detroit, and Miami, for example, although each has been a source of two or more nonfederal systems successfully operating on a continuing basis.

This market could be subdivided further into (a) the amusement and recreational market served by and selling to private firms in the recreation ride industry and (b) the other nonfederal market served by some of the firms that are also involved in the federal market. This latter market includes airport systems that require no federal support because typically they are locally funded by airport revenue bonds.

The primary focus in this paper is on the second AGT market in which the U.S. government, specifically UMTA, is the sole direct or indirect system buyer. This market has many similarities to markets for military and space equipment and, in recent years, those for public bus and rail vehicles. This market includes applications of AGT technology to public transportation outside of activity centers; it is represented currently by only one operating system--that in Morgantown.

There are a number of implications of the government's dominance in this market that are highly relevant to the present status and future prospects of the AGT industry. These implications include

- Business development costs,
- Program continuity,
- Local decision making, and
- Foreign competition.

These implications are discussed in the subsections that follow.

#### Business Development Costs

To protect the interests of taxpayers and to promote healthy competition, the federal government has developed complex procurement procedures that significantly affect the costs of obtaining government contracts. Because allowable overhead rates designed to cover these (and other) costs have been established by the federal government, firms that are successful in obtaining contracts are able to recover many of these costs. However, firms must pay these costs up front, and must be prepared to incur the additional costs required to meet the accounting and record keeping standards specified by the government. Furthermore, no allowances are made to cover any of these costs incurred by firms that compete unsuccessfully for federal contracts.

Clearly, firms that have not previously carried out government contracts are at a distinct disadvantage. As discussed in the next section, this disadvantage has prevented many firms not previously involved in government work from entering the AGT market. Conversely, many firms active in the military and aerospace industries found it relatively easy to enter the market.

#### Program Continuity

The maturation of a high-technology market involving large costs per system must take place over a long time period--decades rather than years. This time scale is hard to reconcile with that of the federal government where Congress changes to some extent every 2 years and the Executive branch, including the major policy makers within the U.S. Department of Transportation, has changed at least every 4

years in recent times. Funding gaps in the AGRT program and the curtailment of the DPM Demonstration Program are two examples of this discontinuity.

As in many other areas of government, the UMTA technical staff has found it impossible to keep the development of the AGT market on a sufficiently fixed course in the face of conflicting legislation by Congress and the intentions of the Administration. This aspect of the AGT market is a more severe manifestation of similar problems in the military and space areas. Clearly, the latter enjoy a greater consensus concerning their desirability and importance than AGT does.

From the viewpoint of the suppliers, these discontinuities and redirections represent added risks and higher potential costs. Only when these factors can be minimized by being relatively unimportant components within a large total volume of business are firms likely to remain involved in the AGT market.

#### Local Decision Making

During the abbreviated life of the DPM Demonstration Program, a new feature of the AGT market became increasingly evident, i.e., the importance of local area decision making. In spite of UMTA's continuing importance as a supplier of funds for AGT systems, plans to implement DPMS had to be approved by the local areas involved. In this regard the AGT market is quite different from the markets for military and aerospace systems. Between the announcement of new funding for DPMS in four cities in 1976 and the end of the program in 1981, three of the local areas had decided to drop out and an elected official from the fourth was instrumental in getting its DPM funds suspended at the federal level.

Clearly, new standards of public participation for all transportation projects and current limitations on local funds, when added to long-standing characteristics of local area governments, such as avoidance of risk and uncertainty and preferences for tried and true approaches, indicated important newly revealed limits on the size of the AGT market. These indications were rapidly understood by the firms active or potentially active in the AGT market.

#### Foreign Competition

A final factor related to the important role of the government in the AGT market is the impact of foreign competition on the U.S. AGT industry (4,5). In recent years, it has become clear that firms in Canada, Germany, France, and Japan have reached levels of AGT technological advancement equal to, or greater than, that of firms in the United States. Also it is accepted generally that the high rate of foreign progress is closely related to the extent to which foreign governments support both AGT research and development and AGT sales in the United States. Foreign governmental support appears to be concentrated on fewer firms per country (except in Japan), to emphasize implementation assistance more than in the United States, and in many instances to provide funding specifically to finance exports. This approach is different from that of the United States and originates, to a large extent, in a basic difference in philosophy between U.S. and foreign governments concerning the relationship of government and individual firms and in the level of support that should be provided to a given market. From the perspective of AGT firms, however, the result is seen as a worldwide market in which nearly all non-U.S. firms have significant advantages not available

to domestic firms. This is true even though "Buy America" legislation penalizes foreign suppliers bidding on U.S.-funded transportation systems.

Experience has shown that the 10 percent cost advantage given to U.S. firms competing with vehicles or systems that represent less than 50 percent of domestic materials or costs is often more than offset by lower bids from foreign firms. In the case of the DPM system procurements, U.S. firms obtained no advantage from "Buy America" provisions, because the value of guideways and other civil construction components could be counted toward the 50 percent domestically originated requirement. As a result, foreign firms could import complete or nearly complete vehicle and control systems, to be combined with domestic civil construction components and final assembly, and avoid the penalty provisions of the "Buy America" act.

#### THE NATURE OF FIRMS IN THE AGT INDUSTRY

In general terms, the firms now, or previously, involved in the AGT industry chose this role based on the resources they had available for the required research, system development, and business development; on their areas of experience and expertise; and on their expectations for the future of the AGT market.

The large level of funds and facilities required for success in the AGT market, combined with the technological risks and uncertainty of the market, effectively have prevented new or small firms from using outside capital to become established in the AGT market. Table 1 gives a list of firms that are now or previously have been active in the federal AGT market. In addition to these firms, four small firms--Alden, Mobility Systems and Engineering, PRT Systems, and Uniflo--have at various times been active in the AGT market. Alden and Uniflo have withdrawn from the industry; Mobility Systems and PRT Systems remain somewhat active in AGT system development and marketing but neither has sold any systems.

Instead a set of large firms or firms with unusually large internal cash funds available to commit to AGTs have dominated the industry. This is borne out by the second column of Table 1, which indicates that the lowest annual revenue in 1980 for any firm in the AGT market was \$517 million. In 1980 these firms had revenues large enough to be ranked among the 500 largest industrial firms in the United States (ranging from 2nd to 425th). By contrast, some of the firms involved only in the nonfederal market are quite small.

Six columns in Table 1 are used to explore the impacts of previous experience and expertise on a firm's decision to enter the AGT market. Four of these columns show the involvement of a firm in the three areas of expertise chosen as potentially relevant for developers of AGT systems:

1. Experience in producing either complete vehicles or major components used in vehicle construction.
2. Experience in developing vehicle control systems involving some degree of automation.
3. Experience in constructing complete transportation systems involving some degree of automation and including vehicles, control systems, and guideways.

The first two areas of expertise, along with guideways, represent the three major subsystems of a complete AGT system. Guideways were not a primary area of expertise for any of the firms considered as

potential participants in the AGT market, although some of the firms do have divisions dealing with general industrial or civil construction activities. Usually, however, these divisions had a low level of involvement in the AGT development programs of their respective firms. The development of complete transportation systems is the area of expertise most closely allied with the AGT industry and also is a common characteristic of the more active AGT firms.

The last three columns of Table 1 give the status of the current role of each firm listed. Four firms with experience in developing complete transportation systems in related fields are currently active in the industry. In addition, with the exception of one firm, each of the active firms has the experience gained in developing previously sold AGT systems. The other is involved to the extent of forming a joint venture for marketing systems produced by other firms. Of the firms that have withdrawn, all possess related experience in developing vehicle components or (more commonly) complete vehicles and two deal with control systems, but none have related experience in the development of complete systems.

Clearly, previous experience in the high-technology aspects of transportation systems has been a bigger factor in a firm's successful involvement in the AGT industry than its ability to build vehicles. Furthermore, previous experience in integrating the various subsystems into a complete automated system has been more important than simply having expertise in one or both of the two major subsystems--vehicles and control capabilities.

The fifth column under the general heading of related experience in Table 1 provides a general statement of the major activities of each of the firms. The few firms that are representative of firms whose major activity is vehicle production--either rail or automotive--have had the smallest role in the past in the AGT industry, and except for Budd's remaining joint venture marketing role, have all withdrawn from the AGT field. The largest group of firms involved are those in the aerospace industry, but only one of these remains.

Other firms remaining in the industry represent a mixed bag of major activities from entertainment and recreational parks (Disney) to materials transportation and heavy construction (VSL). Two specialize in passenger transportation systems; one of these is based in Canada (UTDC) and one operates exclusively in the private recreational park AGT market (UMI). The only U.S. firm currently active in the public market (Westinghouse) is a large electrical equipment firm that has also dominated the airport systems segment of the nonfederal market.

The levels of involvement of the firms remaining in the AGT market are strongly related to the relative size of their resources. The smaller firms have limited their involvement to the nonfederal market. Only the large firms have become involved heavily in UMTA-funded R&D and in selling systems in the federal market. Of course, this correlation is not entirely due to management decisions: a number of firms have bid on AGT work, including system construction in the public AGT market and participation in UMTA-funded R&D, but with limited success.

A final important factor in a firm's decision to participate in the federal AGT market is summarized in Table 1 in the last column under the heading of related experience. This column indicates the extent of each firm's prior experience in bidding for and carrying out major U.S. government procurements, or local procurements, which are partially funded by UMTA. The only firms without this experience are UTDC (a corporation with major funding by the Province of Ontario and with the major share of

its activities involving public sector markets in Canada), VSL, and Disney. A fourth firm, UMI, has had some involvement in UMTA-funded R&D but has not become active in the federal AGT market. The correlation between prior experience with federal procurements and past or present involvement in the federal AGT market is very strong.

This section can be summarized by giving profiles of the typical firms with past or present involvement in the AGT industry. When all such firms are considered, the typical firm is a large Fortune 500 aerospace firm that has prior experience with government procurements that involved developing and constructing vehicles or complete automated transportation systems. In almost every case, the firm's involvement in the AGT market represented a small fraction of total revenues and resources.

When only those firms that remain in the federal AGT market are considered, the typical firm continues to be large and have prior government experience; however, it is probably not an aerospace firm and is more likely to have prior experience in developing and constructing complete systems. Finally, the typical firm currently involved in the nonfederal AGT market is a smaller firm without prior experience in either major transportation systems or components, or in government procurements.

#### THE DYNAMICS OF ENTRY AND EXIT IN THE AGT INDUSTRY

To explain why a large number of firms became active in the AGT industry in the period from 1965 to 1970 and why many of these withdrew over the past 5 years, the characteristics of the firms and the environment in which they found themselves over the past 15 years must be considered. Figure 3 shows the rate of change, in constant dollars, of the U.S. economy for the period from 1967 to 1982. Growth rate peaks occurred roughly every 4 years, in 1968, 1973, 1977, and 1981. The range of peak growth rates of the gross national product (GNP) during these years was +1.9 to +5.8 percent, and the average peak rate was +4.5 percent. The intervening low points were periods of real decline in total economic activity. The range of low growth rates was -1.8 to -0.2 percent, with an average of -0.9 percent.

A time series analysis of total revenues by individual firm reveals similar patterns. The highs and lows of the firms oriented more toward the consumer and the private sector (Westinghouse, Otis, GM, and Ford) tended to coincide with the highs and lows of the GNP. The firms oriented toward the public sector and others involved in the AGT market tended to have wider and more frequent fluctuations in revenue growth that were less likely to match the timing of the GNP pattern. In the 1968 to 1975 period, however, most firms were passing through the same low-high-low growth sequence shown for the GNP in Figure 3. Conversely, in the 1980 to 1982 period, most AGT firms were passing through low growth periods without the slight improvement in 1981 experienced by the economy in general.

A second important external factor for the AGT firms oriented toward the public sector was the pattern of government expenditures for their products during the period from 1968 to 1982. In the beginning of this period in which the Vietnam war ended and the U.S. program to put men on the moon was completed, aerospace and military supplier firms were experiencing significant reductions in the scale of their government work. Significant growth in this source of revenue was not to occur until 1981-1982, when the government's military spending levels greatly increased.

TABLE 1 Summary of Characteristics of Major Firms with Past or Present AGT Involvement

Firm	1980 Revenue (\$ x million)	Related Experience					AGT Involvement			
		Vehicles		Control Systems	Complete Transporta- tion Systems	General Classi- fication	Major US Government Contractor	Past Role	Present Role	Major Activities
		Components/ Complete Units	Types							
Budd (Thyssen AG)	1,285 (a) (15,493)	Both	Rail pass & freight; highway trailers	--	--	Freight Vehicles	Yes	Joint Venture	Joint Venture	With UMI previous- ly; now with foreign firm to market Maglev systems
Pullman (Wheelabrator- Frye Industries)	3,210 (b)	Complete	Rail pass & freight; highway trailers	--	--	Freight Vehicles	Yes	Joint Venture, R & D	Withdrawn	With Bendix for Las Vegas system; never built
General Motors	57,700	Complete	Autos, trucks buses, loco- motives	--	--	Automotive	Yes	R & D	Withdrawn	Air cushion tech- nology, dual mode; constructed system for its own EPCOT display
Bendix	3,895	Compo- nents	Autos, air- craft, mi- litary, space	Military, space	--	Automotive/ Aerospace	Yes	Demonstration system	Withdrawn	TRANSPO '72
Rohr	517	Both	High speed ocean ves- sels; air- craft & space components	--	--	Aerospace	Yes	Demonstration system tem, R&D	Withdrawn	TRANSPO '72, dual mode, AGRT
Ford	37,100	Complete	Autos, trucks	Military, space	--	Automotive	Yes	Demonstration systems, non- federal market systems	Withdrawn	TRANSPO '72, two systems built
LTV	8,010	Both	Aircraft, military & space vehi- cles; aircraft components	--	--	Steel/ Shipping/ Aerospace	Yes	Non-federal market system, DPM bidder	Inactive, re-entry a possi- bility	AIRTRANS; Los Ange- les DPM bid
Boeing	9,426	Complete	Aircraft, military, space	--	Military	Aircraft/ Aerospace	Yes	Federal market system	R&D	Morgantown, AGRT

Otis (United Technologies, Inc.)	1,183 (c) (12,399)	Complete	Elevators (Auto compo- nents, air- craft)	Military	Elevators, escalators	Elevators/ Aerospace	Yes	Demonstration system, DPM bidder in joint venture, non-federal market system	R&D, some activity in non- federal market	TRANSPO '72, DPM bids with MATRA, Duke University system, AGRT
UTDC	--(d)	Complete	Rail Transit	--	--	Passenger Transporta- tion	No (e)	Federal market (DPM) system sale	Active in US federal and Canadian markets	Detroit DPM
Disney	915	--	--	--	--	Entertain- ment	No	Non-federal mar- ket systems	Active in non-federal market	1 airport, 2 recreation area systems
VSL (Losinger, Ltd.)	--(f) (22)	--	--	--	Cable/ materials handling	Cable Transporta- tion	No	Non-federal mar- ket systems	Active in non-federal market	3 private cable systems
Universal Mobility	--(d)	--	--	--	--	Recreation Transporta-	No (g)	Non-federal mar- ket systems	Active in non-federal market	8 recreation area systems
Westinghouse	8,514	Both	Elevators, escalators; rail (inter- city & tran- sit); military, space components	--	Elevators, escalators	Electrical Machinery	Yes	Non-federal mar- ket systems, federal market system (DPM) sale	Active in federal and non-federal markets	1 recreation area, 5 airport systems; Miami DPM

Note: The firms are listed in increasing order of present or previous involvement in the AGT industry. Dashes indicate not applicable.

- (a) Revenue shown for 1977, last year of independent operations. The 1980 revenue of the parent firm, converted to US dollars using average 1980 exchange rates, is shown in parenthesis.
- (b) Revenue shown for 1979, last year of independent operations.
- (c) Revenue shown for 1975, last year of independent operations. The 1980 revenue of the parent firm is shown in parenthesis.
- (d) No information on revenue available.
- (e) UTDC does have extensive experience as a contractor with Canadian governmental units.
- (f) No information available on VSL revenue. The 1979 revenue of the parent firm, converted to US dollars using average 1979 exchange rates, is shown in parenthesis.
- (g) Limited US Government contracts for AGT R&D.

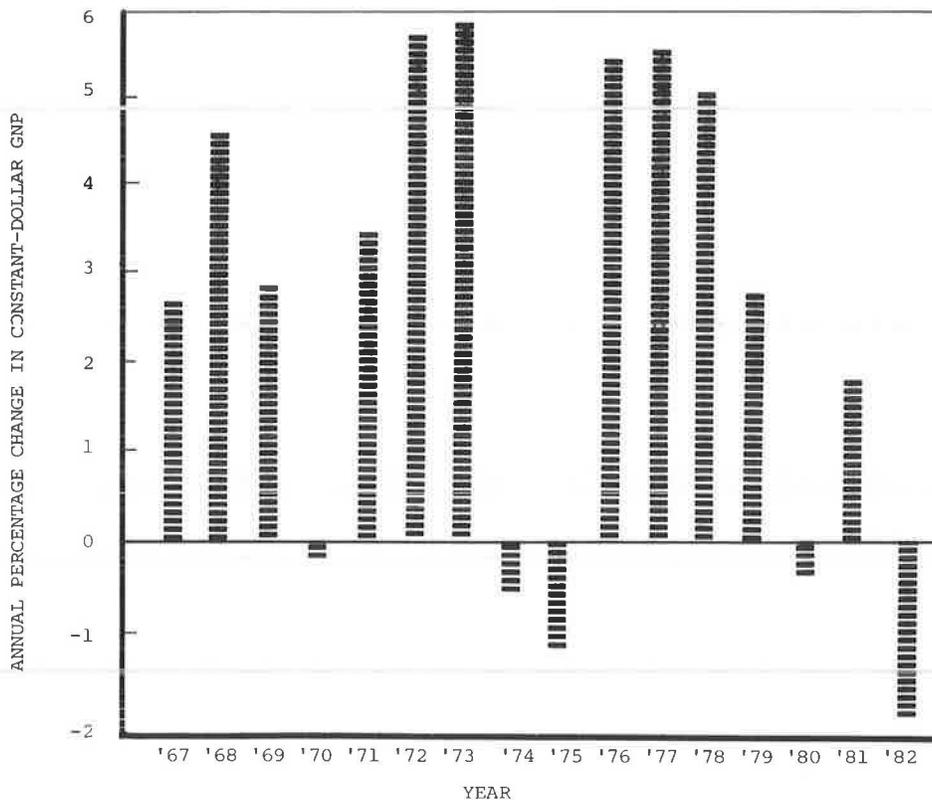


FIGURE 3 Gross national product annual growth rates, 1967-1982 (5).

The decisions of individual firms now or previously in the AGT industry, especially the public sector portion of the industry, can be readily understood. In the years between 1968 and 1972 many of these firms were looking back on a decade of above-average growth that provided ample funds for new ventures as well as for research and development. At the same time they were experiencing the prospects of reduced revenues in their aerospace and military systems activities. As they looked for new market areas, it was natural for them to choose AGT systems for a number of reasons:

1. They expected their experience in developing and building complete transportation systems for aerospace and military applications to be highly transferable to AGT systems.
2. Their experience gained by operating in the arena of government procurements provided them with a base of administrative support that also could be easily transferred to the new area.
3. Following the work done on the 1968 HUD report (3) and the creation of UMTA in the same year, this new agency was highly receptive to the idea of developing AGT systems. During this period, this receptiveness was expressed, among other ways, in a steadily increasing level of funding for AGT research, development, and demonstration activities. Firms considering entry into the AGT industry were thus likely to have high expectations for continuing future government support.

Although not all firms entering the AGT industry during this period fit exactly into this pattern, many did, including LTV Aerospace, Rohr, Bendix, and Boeing. Other firms, which had some of the characteristics described above, became interested in what appeared to be a new and promising industry. They included several large consumer-

oriented firms with resources available for internal investment (General Motors, Ford, Westinghouse, and Disney) and, in limited ways, rail vehicle suppliers (Budd and Pullman). Also a number of new ventures were formed specifically to enter the new market, often as spin-offs of AGT activities in larger firms: Transportation Technology (later purchased by Otis), Universal Mobility, PRT Systems, Uniflo Systems, Alden Self Transit Systems, and Mobility Systems and Equipment.

By 1979 changes had taken place in each of the factors discussed previously. Most of the firms with some AGT involvement were looking back on more than 6 years of significant fluctuations in revenues, profits, and costs, most of which were related to the 1973-1974 and 1979 energy crises. Corporate funds for research and development and for new ventures were much scarcer than they had been in the earlier period. The level of federal funding available for the AGT industry was significantly reduced from that expected between 1968 and 1972 and was frequently only available on an intermittent basis.

The only major federally funded AGT system that had been completed was Morgantown, and the DPM program had not reached the stage of selecting system suppliers. Two of the originally selected DPM cities, Houston and Cleveland, had decided to withdraw from the program, and local opposition was causing delays in two others, Los Angeles and St. Paul. Detroit and Miami remained in the program; however, in these cities the preliminary engineering phase (to be completed prior to selection of a system supplier) was a lengthy process. It became clear to each of the firms involved that the growth of the public AGT market would continue to be much slower and its ultimate potential much lower than they had previously expected.

Another negative factor arose at about this time--the emergence of significant levels of foreign

competition. System development, demonstration, and implementation activities in France, Germany, Japan, and Canada were accelerating. Based on the successes of foreign firms in winning U.S. contracts to supply rail transit vehicles, U.S. firms could expect tough foreign competition for the few public AGT systems that would be built.

The AGT industry was also affected by the bad press associated with the significant start-up problems and higher-than-expected costs of such systems as AIRTRANS and Morgantown. In both cases, the start-up problems were eventually overcome, but the damage to each system's reputation was hard to repair. These damages spilled over to the entire industry and clearly had a significant impact on decision making both at the local level and in Congress.

For a number of firms, the potential market for their systems appeared to be further reduced: the specifications being developed for the DPM systems called for large vehicles and the ability to form multivehicle trains. A number of existing systems could not meet these specifications without major new development work. Neither the funds nor the time required for this work was available.

As these negative factors became clear to the firms in the AGT industry, a number decided to withdraw from the public AGT market. These withdrawals began to occur before 1975; by 1979 five of the firms had withdrawn from the market.

Although the status of the AGT market presented a discouraging picture in 1979, some positive elements existed and these have subsequently been strengthened. The firms remaining solely in the nonfederal AGT market--Disney, UMI, and VSL--have shown no signs of withdrawing, and have continued to sell and implement systems for airports, recreation parks, and hotel complexes. The two firms active in both federal and nonfederal markets--Otis and Westinghouse--have sold private systems recently and have continued their involvement in UMTA-funded R&D, downtown circulation development, and system marketing. In addition, Boeing continues to be active in AGRT R&D; and LTV, although presently inactive, retains the option of returning to an active role. As of mid-1983 the AGT market outlook was brighter than it had been for several years.

The initial uncertainty associated with changing federal priorities has been reduced as federal funding has been continued for the Detroit and Miami downtown circulator systems and for a significant portion of the AGRT R&D program. Firms suggesting at the end of 1981 that their withdrawal from the industry was a significant possibility are now planning to market control subsystems that represent spin-offs of their UMTA-funded R&D. It has become clear, however, that at least one foreign firm, UTDC, will continue to be an active competitor in the U.S. market; its contract to build the Detroit circulator plus its sales of two systems in Canada virtually assure this.

#### FUTURE PROSPECTS FOR THE AGT INDUSTRY

It would be a mistake to assume that the present relatively stable, if significantly reduced, level of involvement of firms in the AGT industry will continue indefinitely. The rapid rates of change observed in the past 15 years may not continue into the future, but further changes are sure to occur. Predicting whether the overall effects will be a stronger or a weaker industry, with more or fewer firms involved, is difficult under any circumstances. If probable trends in the various relevant factors discussed previously are considered, how-

ever, educated guesses can be made with increased assurance that they will be borne out by future events. Before reaching conclusions on the future of the AGT industry, these various trends will be reviewed.

#### Positive Trends

The GNP growth rate is currently moving upward and is expected to continue to do so for more than a year. This growth is likely to be reflected also in the revenues and profits of the firms in the AGT industry. These trends can be expected to strengthen the AGT industry in two ways: the firms now involved will be less likely to withdraw and the level of sales activity in the nonfederal AGT market is likely to increase. Another positive trend is that the public reputation of AGT systems has improved as the early start-up problems tend to be forgotten and the continuing successful operations of the existing systems become more generally known. A final positive trend is the realization by AGT firms that the control subsystems and other AGT components they are developing and testing, such as electric motor speed controls for conventional rail systems, may represent significant spin-offs into potentially large related transportation markets.

The existing trend in the demand for AGT systems represents a factor that can have mixed impacts on the AGT industry. Interest in building nonfederally funded systems appears to be increasing slowly as the general economy improves. There is likely to be a wait-and-see attitude in the federal market until the systems now being constructed in Miami and Detroit have proved themselves. If these systems are implemented without major operational or financial setbacks, and are well accepted by the local residents, the demand for similar systems in other areas will begin to materialize. Any setbacks that occur will undoubtedly be highly publicized; and even if they are subsequently overcome, they will inhibit the demand elsewhere.

#### Negative Trends

The generally low levels of corporate profits over the past 2 or 3 years mean that there are now reduced levels of internal funds available for R&D. As a result, currently involved firms will continue to be cautious about expanding their investment in AGT systems, and other firms will be highly unlikely to consider entering the industry.

Major increases in federal funding for AGT programs are generally recognized to be quite unlikely. Congress has kept the existing R&D and implementation activities going at reduced levels, but high federal deficits and many competing programs are likely to keep AGT funding levels from growing significantly.

Trends in government policies are also likely to be negative factors in the foreseeable future. Fiscal constraints will be hard to overcome even if the current administration, or a future one, were to change its policy on funding new transportation technologies. Also, the levels of government funding in the industry's competing areas of aerospace and military systems are not likely to decrease drastically.

A final negative factor is the reality of continued strong foreign competition. Although the present demand for AGT systems remains lower in all countries because of the recent worldwide economic recession, foreign firms have been successful in the

U.S. rail transit vehicle market and in competition for the Detroit downtown circulator. As a result, foreign firms can be expected to continue to compete actively for both federally and nonfederally funded U.S. systems in the future.

#### Summary

When these positive and negative trends are considered together, they suggest that the AGT industry will remain at its current reduced level for the foreseeable future. The market for nonfederally funded systems may grow slowly but probably not enough to attract new firms. The uncertainties of the continuation of a market for federally funded systems will surely keep new firms from entering this market, but the existing firms are likely to remain to compete for any new work that does materialize because they will continue to be involved in the larger closely related nonfederal and foreign markets.

The firms now involved in the AGRT R&D program will continue this role as long as federal funding is available and will also look for opportunities to expand into sales of related products. However, because the objectives of the present R&D activities are control subsystems rather than complete AGT systems, these firms are not likely to return to the complete-system market. Also, they will be seeking to broaden their product applications to include conventional rail transit vehicles, aerospace systems, and so forth.

There are likely to be both positive and negative impacts on the U.S. AGT industry because of the expansion of activity in the market by foreign firms. The number of AGT system sales by U.S. firms may be reduced, but many of the components of these systems will be produced in the United States, often by the same firms marketing U.S. systems. In addition, the formation of multinational joint ventures to assemble and market foreign systems in the United States is likely to continue, providing a way for both present and new U.S. firms to keep involved in the AGT industry.

It must be emphasized that these expectations apply to the foreseeable future, based on observed trends in each of the factors believed to be important to those deciding on corporate strategies in the AGT industry. It is only possible to speculate on what might occur in the more distant future. Cycles of general economic growth and decline are sure to continue, but their timing will always be highly uncertain. If the current growth pattern is sustained for a number of years, potential U.S. AGT firms will again have the resources required to invest in the industry. Whether they will do so, and the extent to which they will focus on the federally funded portion of the market, will depend strongly on their perception of whether the demand for AGT systems is growing, on how the related markets for aerospace and military systems are changing, on

stated federal policies concerning support for AGT development and implementation, and on the continuing and stable existence of programs funded by UMTA in these areas. Clearly, significant changes from current trends in many of these areas will be required if the AGT industry is to experience a major expansion. Furthermore, it is clear that the federal government, and UMTA in particular, will have a high level of influence on any changes that occur in these trends, and thus in the AGT industry, in the coming years.

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All views expressed in this paper are those of the authors and not necessarily those of the federal government or of the representatives of AGT firms who were interviewed.

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