UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

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COMMUNITY AND ECONOMIC
DEVELOPMENT DIVISION

B-205902

JANUARY 20, 1982


The Honorable Drew Lewis
The Secretary of Transportation

Dear Mr. Secretary:

Subject: UMTA's Research and Development Program Should Pay Closer Attention to Transit Industry Needs (CED-82-17)

We have reviewed the Urban Mass Transportation Administration's (UMTA's) research and development program and identified several management weaknesses in the program that warrant your attention. We found that UMTA:

--Does not have a means of ensuring that projects it undertakes are addressing the transit industry's most important needs.

--Is spending research funds and effort on solving problems that the private sector is addressing on its own.

--Does not identify or consider barriers that prevent intended users from accepting or adopting research results.

## BACKGROUND

Section 6 of the Urban Mass Transportation Act of 1964, as amended, provides UMTA broad authority for research, development, and demonstration projects to reduce mass transportation needs or increase mass transportation service at minimum cost. UMTA tries to meet its goal of improving long-term mass transportation productivity, efficiency, and service by providing its grantees with innovative equipment, service concepts, and management techniques for providing transit services. UMTA carries out its research activities for both publicly and privately owned segments of the transit industry, consisting primarily of operators but also planners and equipment suppliers and manufacturers. According to UMTA, it is supposed to

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concentrate its research effort on projects that the industry is unwilling or unable to address on its own.

Since UMTA was established in 1968, the Congress has appropriated it about $660 million for research. Its research activities are administered from UMTA headquarters in Washington, D.C., by 12 offices under three associate administrators. The transit industry--the ultimate consumer of UMTA's research--is under no obligation to use the research results and will accept and adopt only those products it feels it needs and can use readily.

## UMTA LACKS A MEANS OF ENSURING THAT ITS RESEARCH PROJECTS MEET TRANSIT INDUSTRY NEEDS

UMTA relies on each of its 12 research offices to determine what research should be done within their individual mission and responsibility areas. However, it does not determine or require the research offices to determine the industry's research priorities. As a result, UMTA projects do not always address important industry needs and research results are not always adopted. Eleven of 18 transit industry representatives we contacted did not believe that UMTA's research addresses industrywide problems or provides them with practical benefits that they can use readily.

## UMTA's research program has had mixed results

UMTA's research program to date has had mixed results. Some research products, such as the urban transportation planning system and rapid rail construction techniques, have been adopted. According to UMTA, cities building new rapid transit systems have saved tens of millions of dollars in the design of subways, elevated track, third rail power conductors, and tunnel ventilation as a result of UMTA's research in construction techniques. For example, UMTA estimates that Metropolitan Dade County (Miami, Fla.) alone saved at least $6.6 million by using design criteria validated through UMTA's research program as opposed to using the traditional design.

On the other hand, UMTA has spent large amounts of time and money on projects that have not been adopted for public transit systems. For example, UMTA undertook the following four projects in fiscal years 1971 and 1972 at a total cost of more than $137 million:

--A standardized bus, called transbus, was developed at a cost of over $28 million. However, no manufacturer was willing to build it because of major engineering, operating, and performance problems with the specifications and so it was never put into production.

--A standardized rapid rail vehicle, the so-called advanced concept train, cost over $27 million to develop but never made it beyond the prototype stage. We were told that the former Associate Administrator for Technology and Development and Deployment believed this project was not successful because UMTA tried to develop too much new technology in one project.

--The urban tracked air cushion vehicle, costing more than $17 million, and the personal rapid transit system, costing more than $65 million, were UMTA attempts to develop totally new mass transit systems. While the personal rapid transit system is being used at West Virginia University in Morgantown, West Virginia, and many of its features have been incorporated into systems operating in controlled environments such as airports and amusement parks, neither this system nor any similar system has been adopted for public transit operations. The urban tracked air cushion vehicle is now in a museum.

In the mid-1970's, UMTA recognized that many of its research efforts were not being used by the transit industry, and as a result it began initiating more short-term, management-oriented projects. Because it often takes from 10 to 15 years from the time a project starts until its results can be made available and applied by the transit industry, and because UMTA does not routinely collect and analyze information on industry adoption of its research results, we could not evaluate the effect of UMTA's shift to short-term projects.

Our discussions with management officials of the 18 transit properties contacted and a contract management firm that manages the daily operations of 44 transit systems throughout the United States showed that, with few exceptions, they do not look to UMTA's research program to provide them with innovative products, concepts, or techniques. Six of these properties are among the 11 largest properties in the country. (A listing of transit properties we contacted is shown in enc. I.)

Management officials of six of the properties believed that UMTA research program officials were not aware of or did not understand the transit industry's needs, and as a result products developed were not always useful or practical to deploy. Officials at 12 of the properties contacted believed that UMTA's research program primarily benefited large transit systems and that it concentrated on developing products that are too sophisticated and complex for most transit operators. Representatives of five of the six larger properties believed that UMTA's research program was responding to at least some of their needs. On the other hand, representatives of 10 of the 12 remaining properties and the contract management firm contacted believed that UMTA's research program produced few products that were of benefit to them. Officials at 10 of the transit properties--both large and small--believed that UMTA's research program should be addressing more of the basic problem areas common to all transit operators, such as maintenance, training, and safety.

## UMTA identifies research needs, but does not analyze them

UMTA directly sponsors two processes for identifying transit research needs: periodic research and development conferences and the national cooperative research and development program. Research needs are also identified by several other organizations made up of various segments of UMTA's constituency, including transit operators; State and local government officials; transit industry suppliers, consultants, and equipment manufacturers; and the academic and research communities. However, UMTA does not analyze the information identified through these processes. Without evaluating the commonality, magnitude, and financial and social impact of identified needs, UMTA management cannot know whether projects undertaken are addressing widespread, important needs of the transit industry as a whole.

Between 1976-80, UMTA sponsored four research and development conferences with participants from its own research program staff and representatives of transit users, public transit system operators, equipment and service suppliers, the research community, and all levels of government. According to UMTA, one purpose of the conferences is to enable UMTA staff to communicate directly with the various groups represented there. However, UMTA does not rank the needs expressed at the conferences into priority order or use them to develop a comprehensive research program plan. Instead, it simply compiles, publishes, and distributes the material presented at the conferences.

In 1979 UMTA established the national cooperative research and development program to provide its principal client groups--transit operators and State and local government officials who are responsible for providing transit services--with a means of

attempting to resolve short-term public transportation problems through applied research, development, test, and evaluation. The program is guided by a technical steering group consisting of representatives of transit operators, State departments of transportation, local governments, and UMTA's Office of Technology Development and Deployment. The steering group identifies problems, ranks them in order of priority, and establishes an annual program of projects to be carried out under an UMTA contract with the Transportation Research Board. The problem is that the steering group establishes priorities only for projects that can be carried out under the program's limited funding--currently about $1 million a year. Therefore, projects requiring substantial research funds could not be funded even if they were of national significance.

At least four other organizations--the Transportation Research Board; the American Public Transit Association; the Urban Consortium for Technology Initiatives; and the Intergovernmental Science, Engineering, and Technology Advisory Panel--have identified research needs from their individual perspectives. With the exception of the American Public Transit Association, these groups do not isolate transit needs but rather include them as part of their consideration of total transportation research needs.

UMTA relies on each of its 12 research offices to identify needs and determine which projects should be undertaken within their individual mission and responsibility areas; it does not determine overall research program priorities. UMTA research program and project managers generally identify needs through (1) their contact with representatives of their constituency, which are primarily transit operators but sometimes include planners or other State and local government officials, (2) their reading of various industry, technical, and other professional publications, and (3) their attendance at conferences, workshops, and seminars sponsored by UMTA and other organizations such as the American Public Transit Association.

We found that only 2 of the 12 research offices have established a systematic process for identifying and ranking research needs within their mission and responsibility areas. For example, the research planning methodology prepared for the Office of Rail and Construction Technology included the following three steps:

1. Developing a data base that can be used to estimate potential savings of various research projects. During this step, information such as construction, power, and maintenance costs of various systems and subsystems is collected and made part of the data.

2. Developing a list of potential rail and construction technology research projects. During this step, a literature search is conducted; meetings with representatives of operating properties, engineers, and other professionals working in public transportation are held to discuss research needs; common activities are combined and structured into project areas; and the costs and benefits of each project are estimated.

3. Developing a methodology for project evaluation and selection. During this step, a model is used for selecting projects that will provide the most useful research with available funds.

In April 1981 UMTA's then Associate Administrator for Technology Development and Deployment participated in hearings on mass transit research and development before the Subcommittee on Transportation, Aviation, and Communications of the House Committee on Science and Technology. He stated that one reason a number of UMTA research products had not been deployed is the lack of industry support and endorsement of the projects undertaken. We believe that without a systematic process for identifying and evaluating transit needs or problems, research managers do not know the scope, importance, or potential benefits of a proposed research project.

## UMTA AND PRIVATE INDUSTRY ARE CARRYING OUT SIMILAR RESEARCH

We found that similar research is being carried out by UMTA and private industry. As we noted on page 1, UMTA says its research program was intended to provide research that the transit industry was unwilling or unable to carry out itself. We believe that in cases where private industry is interested in a specific research proposal but is unwilling to undertake all the costs or risks associated with it, UMTA could work cooperatively with industry. In that way, the research could be carried out jointly at less cost to each party. Cooperative efforts could also reduce barriers to research use (a problem discussed later).

During this review, we identified five areas where UMTA and the transit industry were working on similar research projects. Following are two examples of research that UMTA and private industry carried out at the same time.

### Example 1

Since 1968 UMTA has been supporting research on automatic vehicle monitoring systems--an electronic system of monitoring

the location and operational status of vehicles on city streets--to increase a transit system's safety and productivity. In 1968 UMTA awarded a $1.6 million demonstration grant to a transit operator to develop a system incorporating automatic vehicle monitoring technology to provide more management control over buses and greater safety for drivers and passengers. In 1973 the Department of Transportation's Transportation Systems Center evaluated the system and found it inoperable because of poor equipment reliability and design scope.

UMTA believed that the system had not been adequately demonstrated and tested, so in 1975 UMTA's Office of Bus and Paratransit Technology undertook another project to develop a system using the same technology. The new system included many additional functions and capabilities, and UMTA continued to enhance the system during its development. Demonstration and evaluation of this system was scheduled to be completed in September 1981. The total cost of this project is about $13 million.

Concurrently with UMTA's program, several manufacturers have developed systems that use automatic vehicle monitoring technology and are capable of performing at least some of the same functions as UMTA's system. In 1976, a transit operator and a manufacturer began jointly developing a system using similar technology. UMTA evaluated this system in 1979 and found it to be both feasible and cost effective. Although this system is not able to perform all the functions of the UMTA-developed system, the manufacturer has a similar system for sale. In another case, a transit operator developed a system on its own, using vehicle location technology, which it believes is simpler than the one UMTA developed and is demonstrating. The operator has applied for UMTA capital assistance grant funds to install this system.

Example 2

UMTA's Office of Bus and Paratransit Technology awarded one bus manufacturer an $88,833.87 contract in 1976 for designing a wheelchair lift device that could be installed on existing buses, even after two other bus manufacturers informed UMTA that they had been developing that kind of equipment on their own. One of these manufacturers declined to participate in UMTA's program because of potential conflicts over patent rights.

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In the first example, our review showed that UMTA did not contact manufacturers to determine their willingness or ability to develop such a system on their own. In the second example, the project manager went ahead and funded the project after he became aware that industry was carrying out similar research.

UMTA's Executive Director agreed that UMTA should not be doing research that the industry is willing and able to do on its own, but stated that in some instances similar research may have been carried out because the Congress has mandated that UMTA do it. We are aware that some UMTA research has been carried out in response to congressional mandates, but we did not find any evidence that this was the case in the examples we identified. We believe that similar research is being done because UMTA research program and project managers are not required to assess the industry's willingness or ability to carry out the research on its own or to participate jointly with UMTA in carrying out the research. 1/

When private industry is willing to carry out research on its own, UMTA could use its research funds more effectively by monitoring, evaluating, testing, and disseminating the results of those research activities to the rest of the industry. For example, UMTA's Office of Rail and Construction Technology has used this technique to observe, test, evaluate, and disseminate information on different rapid rail construction techniques used by various transit systems.

## BARRIERS TO INNOVATION ARE NOT IDENTIFIED OR CONSIDERED DURING THE RESEARCH PROCESS

UMTA does not require that potential barriers to innovation be identified or addressed during the research process and, as a result, obstacles that may delay or even prevent use of the research have not been recognized and dealt with. Sometimes the cost or complexity of the product precludes its adoption by more than a few transit operators.

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1/Generally, the Government obtains ownership of all information developed as a result of federally funded research and development. However, when a grantee or contractor makes a substantial contribution of funds, facilities, technology, or equipment, the Government may waive its ownership rights and allow the grantee or contractor to retain them. According to the Department of Transportation's Office of the General Counsel, the waiver of the Government's ownership rights in return for a substantial contribution from the grantee or contractor is equitable as long as the product is made available on reasonable terms.

As noted on page 4, many transit operators believe that UMTA's research program is developing equipment too complex or costly for most transit operators to adopt. For instance, one transit operator told us that UMTA research involving the use of computers to assist in planning, management, and operation of transit systems cannot be used effectively and efficiently by most transit properties because their operations are not large enough to justify computer use. Other transit operators also stated that they did not find UMTA's research involving computer applications useful or beneficial and believed it was being developed for use only by large systems.

Officials of one large transit property stated that although the transit property only pays 20 percent of the cost of new equipment--UMTA capital grants generally fund 80 percent of the cost--management must be concerned with whether it has or can get adequately trained personnel to use the technology and whether it can afford to operate and maintain it. These decisions are important to industry in determining whether to implement new technology.

UMTA has recognized that financial and institutional barriers are another reason its research results have not been accepted or adopted by the industry. However, because UMTA does not require its program or project managers to identify these barriers before research projects are initiated, they are not being recognized or dealt with until after the research is completed. For example, UMTA developed a set of computer programs to assist transit properties with assigning vehicles to trips and drivers to vehicles. An analysis of the costs and benefits associated with this system performed after the system was developed showed that the benefits were close to zero. According to the UMTA project manager, other reasons transit operators did not accept the system were that some jobs were threatened and people with specialized skills and abilities would have to be hired. In addition, he stated that the high cost of adapting the program to individual properties may have prevented many transit operators from adopting it. We believe that if these barriers had been identified before the project was initiated, the feasibility of overcoming them could have been assessed and, as much as possible, addressed as the research was being carried out.

In another case, a program manager recognized that a number of barriers to the industry's use of a project existed but did not believe that they should affect the decision to develop the product. He stated that development was his focus and that the deployment problems would be handled by another research office after his office had developed the product.

By waiting until research is completed, UMTA program managers are operating under the assumption that barriers can be overcome at a reasonable cost within a reasonable time frame. However, this has not always been true. For example, the UMTA program director at the Transportation Test Center in Pueblo, Colorado, stated that although UMTA had successfully developed the magnetic levitated vehicle and the tracked air cushion vehicle, the industry could not deploy the technology because it was too costly.

Sometimes, research performed does not reflect a good understanding of transit operations and, as a result, anticipated benefits cannot be achieved. Several transit operators contacted during this review believed that UMTA's research program managers were not familiar with how transit systems operated and thus many projects were not operationally feasible. For example, UMTA's analysis of the benefits of using automatic vehicle monitoring techniques showed that the greatest benefit of this technology was that dispatchers would be able to control bus operations, thus allowing transit properties to replace street checkers or supervisors. Three of the largest operators contacted during this review indicated that they would not be interested in eliminating either street checkers or supervisors because they performed other functions that the automatic vehicle monitoring system could not perform or they believed the functions were best performed by these personnel.

## RESEARCH PROGRAM POLICY AND PROCEDURES ARE NEEDED TO IMPROVE PROGRAM EFFICIENCY AND EFFECTIVENESS

We found that UMTA has not established an agency research policy or procedures that would provide its research offices and staff with standard criteria for planning and carrying out their research activities. An agency research policy would be difficult to establish given UMTA's current organizational structure and management philosophy. The director of UMTA's Office of Policy Development believes that each associate administrator should develop the policy and procedures needed to carry out the programs for which he is responsible. But, because three associate administrators are responsible for carrying out the agency's research activities, an agency research policy could not be developed. Thus, other than formal statements made from time to time before congressional committees, UMTA has not developed a research policy.

We discussed this issue with UMTA's Executive Director. He advised us that the UMTA Administrator submitted a proposed UMTA reorganization to the Secretary of Transportation in December 1981 that, if approved, would result in one associate administrator being responsible for all the agency's research

activities authorized under section 6 of the Urban Mass Transportation Act of 1964, as amended. According to a memorandum issued by the Administrator in October 1981, the reorganization proposal was developed as a result of two working group studies and review by UMTA's executive staff of the agency's mission, management, organization, and processes begun in March 1981. The Executive Director also agreed with the need for an agency research policy and procedures. He believed that the policy should be developed by the Office of Policy Development and the procedures should be developed by the associate administrator responsible for carrying out the program.

## CONCLUSIONS

While UMTA recognizes that its research should be directed at what the transit industry needs, it has not designed a means of ensuring that its research program is directed at the most important, widespread industry needs. Furthermore, because UMTA does not require it, research program managers do not systematically identify and analyze industry needs so that research projects can focus on the highest priority needs.

Similar research is being carried out by both UMTA and the transit industry in several areas. In cases where transit suppliers and operators are already involved in research, UMTA's funds would be spent more efficiently if UMTA worked cooperatively with industry in the research or offered to test, evaluate, and disseminate research results.

Innovative products and techniques resulting from UMTA's research will not be deployed unless certain barriers can be overcome. These barriers include the cost of deployment, operation, or maintenance and the need to hire specially trained personnel to operate and maintain new technology. Program and project managers do not always attempt to identify potential barriers to deployment or assess whether they can be overcome. As a result, some transit officials view UMTA's research results as too complex or sophisticated for most transit operators to use and some transit industry representatives view UMTA's research results as unrealistic or impractical for actual transit operations.

We believe that if UMTA's proposed reorganization is carried out, and an agency research policy and procedures for carrying out the program are developed, UMTA's research funds could be used more efficiently and effectively.

## RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

Our recommendations are intended to make UMTA's research results more acceptable and useful to the transit industry, to

improve the use of UMTA research funds, and to steer UMTA away from research that private industry is willing and able to conduct on its own. Specifically, we recommend that you direct the Administrator of UMTA to:

--Establish a policy requiring UMTA research offices to identify systematically the industry's needs within their individual mission and responsibility areas and analyze those needs to determine research priorities.

--Require program managers to assess thoroughly the transit industry's willingness and ability to carry out a proposed research project on its own. In cases where industry is developing or experimenting with innovative equipment, concepts, or techniques, limit UMTA's involvement to testing, evaluating, and disseminating the results.

--Require program managers to explore and identify potential barriers to industry's acceptance and use of proposed research and work to overcome these barriers as part of the research process.

## OBJECTIVES, SCOPE, AND METHODOLOGY

We undertook this review because the Congress has expressed concern over the fact that the transit industry has not accepted many of UMTA's major research projects. Our objective was to search for causes of this situation and recommend improvements.

Our review was conducted in California; Massachusetts; and the Washington, D.C., metropolitan areas because our analysis of ongoing projects in fiscal year 1978 showed that these areas accounted for more than half of the number of and amount spent on all mass transit research and development projects. These areas also provide a good mixture of the types of organizations involved in the research program, such as universities, contractors, public interest groups, and transit operators.

We reviewed research projects at UMTA headquarters and the Transportation Systems Center to determine how UMTA selected and managed projects and how it disseminated research results. We had trouble selecting projects for review because no comprehensive, up-to-date list was available of ongoing and completed projects. Therefore, we selected projects for review based on our judgment of the best information available. Projects we cite as examples do not represent a statistical sample. A total of 26 programs and projects, initiated between 1971-80, were reviewed in depth. We attempted to select at least one project to review from each office involved in research and

development; projects selected included completed, ongoing, and recently initiated projects to achieve balance.

Selected aspects of other research projects were also reviewed, and we analyzed Office of Management and Budget circulars and Department of Transportation and UMTA policies, procedures, and requirements related to the research program. In addition, we interviewed officials of all major organizations representing UMTA's constituency to determine, from a user's perspective, if UMTA's research program adequately addresses their needs and disseminates research results. The individuals interviewed included representatives of transportation commissions, metropolitan planning organizations, large and small transit operators, contractors, public interest groups, and universities. A listing of organizations contacted during the review appears in enclosure I.

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As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

Sincerely yours,

Henry Eschwege

Henry Eschwege
Director

ENCLOSURE I

## LISTING OF ORGANIZATIONS

## CONTACTED DURING OUR REVIEW

TRANSIT OPERATORS:

Chicago Transit Authority, Chicago, Illinois
Long Beach Transportation Company, Long Beach, California
Lowell Regional Transit Authority, Lowell, Massachusetts
Massachusetts Bay Transportation Authority, Boston, Massachusetts
Metropolitan Transit Authority, Baltimore, Maryland
Metropolitan Transit District, Santa Barbara, California
New York City Transit Authority, New York, New York
North County Transit District, Oceanside, California
Orange County Transportation District, Garden Grove, California
Norwalk Transit System, Norwalk, California
Pioneer Valley Transit Authority, Springfield, Massachusetts
Phoenix Transit System, Phoenix, Arizona
Queen City Metro, Cincinnati, Ohio
Rhode Island Public Transit Authority, Providence, Rhode Island
Rochester-Genessee Regional Transportation Authority, Rochester, New York
San Diego Transit Corporation, San Diego, California
Southern California Rapid Transit District, Los Angeles, California
Washington Metropolitan Area Transit Authority, Washington, D.C.

OTHER GRANTEES, CONTRACTORS, AND PUBLIC INTEREST GROUPS:

American Public Transit Association, Washington, D.C.
Area Planning Council, Santa Barbara, California
ATE Management and Services Company, Cincinnati, Ohio
California Department of Transportation, Sacramento, California
California State University at Long Beach, Long Beach, California
Comprehensive Planning Organization, San Diego, California
General Motors Corporation, General Motors Transportation Systems Division, Warren, Michigan
International City Managers Association, Washington, D.C.
Los Angeles County Transportation Commission, Los Angeles, California
Maricopa Association of Governments, Phoenix, Arizona
Massachusetts Institute of Technology, Cambridge, Massachusetts

ENCLOSURE I

McFarland Design, Inc., Santa Barbara, California
Minicars, Inc., Golita, California
Orange County Transportation Commission, Santa Ana, California
Public Technology Incorporated, Secretariat for the Urban Consortium for Technology Initiatives, Washington, D.C.
Public Transit Administration, Phoenix, Arizona
Southern California Association of Governments, Los Angeles, California
Transportation Research Board, Washington, D.C.
University of California at Irvine, Irvine, California
University of California at Los Angeles, Los Angeles, California
University of Southern California, Los Angeles, California
Urban Institute, Washington, D.C.