*Abridgment*

# Interfacing Transportation Modes for Access to a Central Business District

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A regional Metrorail system currently under construction in the greater metropolitan Washington, D.C., area is designed to create high-accessibility corridors in the region by providing a 156.8-km (98-mile) transit-network system. The city of Alexandria, Virginia, is located approximately 16 km (10 miles) south of Washington, D.C. The proximity of Alexandria to the nation's capital and the historic nature of that area render a flavor to this city that is somewhat different from the majority of urban areas. There will be two Metro stations located on the western edge of the central business district (CBD), and the Metro route will parallel the existing railroad right-of-way.

It must be recognized, however, that the Metro system will not offer a panacea to all of the transportation problems in the region. For example, the system will not provide a door-to-door transportation service. The success of the system is partially contingent on an adequate interfacing of the Metrorail (the primary mode) with a proper distributor or minitransit system (access mode) that will provide critical linkages between the stations and the diverse land uses within the CBD area.

The specific objectives of this study were

1. To estimate the desires of travelers in the CBD area of Alexandria in relation to the two Metro stations;
2. To investigate a series of small-scale transit systems that would interface between the primary and access modes, and to select a generic type of vehicle that is based on level of demand, urban design, and operational, environmental, and community-acceptance criteria; and
3. To recommend a series of preliminary corridors for the proposed minitransit system.

The study area essentially covered the entire CBD of Alexandria. The area is bounded on the west by a railroad line, on the north by the limits of development along an existing parkway, on the south by a controlled-access highway that surrounds the metropolitan area, and on the east by the Potomac River. The railroad, freeway, and river present physical barriers to movements and channelize traffic through a few portals into and out of the study area.

## STUDY APPROACH, METHODOLOGY, AND RESULTS

### Land Use Modeling

The system approach that was established at the outset of the study used travel demand estimates that were developed from the critical inputs of the land use model for the design year 1992. It was recognized that the study area could develop in a number of ways under different sets of growth assumptions. Thus, two alternative growth plans for the study area (residential growth and commercial growth models) were developed. These models were designed to reflect the extremes of growth potential over the next 20 years (1). Estimations of population and employment figures for the residential model were 25 900 and 17 500 respectively, and the corresponding figures for the commercial model were 23 600 and 20 700.

### Travel Forecasting Model

TRIMS (Transportation Integrated Modeling System) was developed by the Metropolitan Washington Council of Governments (COG) and was used to develop patronage estimates for the proposed minitransit system (2, 3). The model was designed as a quick-response transportation planning procedure and has the capability of focusing on a small area (micro level) within the context of a regional background (macro level). The model had already been calibrated by COG with regional data. The following process within the model was used to estimate travel demand:

1. A regression technique to determine trip generation,

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2. A gravity model technique to determine trip distribution,
3. A modal split (disutility function) to separate person trips between automobile and transit,
4. A model for automobile occupancy to convert person trips by automobile into driver and passenger trips, and
5. Assignment of automobile trips to a travel network.

Essentially, the modeling was performed at the macro level in two parallel channels that represented the two basic trip purposes of work and nonwork. The work-trip distribution was on a person basis, and then a modal-split model was applied to separate the transit trips from automobile trips. The person work trips by automobile were subsequently adjusted for a proper automobile-occupancy factor to yield driver trips by automobile. Thus, the non-work-trip distribution was accomplished for automobile trips only and for three separate nonwork purposes. The resulting table for nonwork trips by automobile was merged with the work trips by automobile, was split to zone level in the micro analysis area, and was assigned to the highway network. Since nonwork transit trips were not accounted for in the basic TRIMS model, a procedure for estimating these trips was developed as a part of this study. Walk-in and tourist trips constituted a third element in the candidate trip table. These trips were not included in the TRIMS output, but were independently compiled and added to the total trip matrix (4).

The transit trip table obtained from TRIMS was adjusted to include the nonwork component of such trips, since TRIMS could only account for transit work trips. The transit trip table was also split from the district to the zone level to make it compatible with the table for automobile trips. A third important adjustment to the transit trip table was to assign the internal-external trips to one of the two Metro stations in the study area.

The zonal trip table obtained from the TRIMS program was reformatted to include only the internal-internal trip interchanges since these trips were considered the only candidates for the minitransit system. The table for driver trips by automobile was converted into a table for person trips by automobile by applying an appropriate automobile-occupancy factor.

### Trip Desires Relative to the Minitransit System

An assessment of the order of magnitude of the travel demand for the minitransit system was made by applying a high and a low modal split (secondary) on each of the candidate trip tables and then by combining the respective tables. The assumptions that led to an assessment of these secondary modal-split factors for transit, driver trips by automobile, and walking trips were respectively as follows.

1. A relatively high range of modal split (80 to 100 percent) was assumed in view of the potential attractiveness of minitransit service, the absence of any parking facility in the station areas, and the problems associated with having to coordinate the schedules of two people to make a single trip (kiss-and-ride).
2. It was assumed that between 20 and 50 percent of the candidate person trips by automobile would actually be attracted to the minitransit system. The rest would continue to drive their automobiles for trips within the study area.
3. It was assumed that 50 percent of the candidate walking trips would be diverted to the minitransit system. Theoretically, all walking trips may be diverted to the minitransit system, if the quality of service is considered ideal. The figure is likely to be substantially lower when factors such as cost, convenience, walking distance, and waiting time are considered.

### Results of Patronage Forecasting

1. The range of trips projected for the minitransit system in 1992 varied from 30 000 to 40 000 trips/d. The range is caused by the use of the two alternative growth model projections that allow for both liberal and conservative assumptions concerning changes in population, housing, employment, and income during the study period.
2. The 2-h peak-morning traffic, which is expected to use the proposed transit system under varying land use and modal-split assumptions, was estimated to be within a range of 6400 (low) to 8600 (high) (5). These numbers were the basis for calculating the number of vehicles and schedules for the proposed transit system.
3. The patterns for the traveler's desired lines for a minitransit system indicated heavy volumes for both Metro stations. It was indicated that the highest level of interzonal demand is between the north waterfront, where dense residential development is expected, and the Braddock Road station.
4. The analysis showed that the critical areas to be served by the minitransit system are the two Metro stations and the core of the downtown area. The peak hours of the internal trips are likely to occur during the midday, due to a large number of walking trips. The peak hours for travelers using the Metro for work trips are expected to be during 7 to 9 a.m. and 4 to 6 p.m.

## SYSTEM ANALYSIS

### Urban Design and Community Impact Factors

In view of the historical nature of the study area, it was recognized that the impact of an overhead transit system such as personal rapid transit (PRT) vehicles moving on a fixed guideway would be very different from that of a minibus system. In general, an overhead structure that supports transit vehicles would have columns with concrete beams spaced every 15.3 to 22.9 m (50 to 75 ft). The catenaries that provide power for an electric streetcar or trolley would generally require poles every 30.5 m (100 ft), and the arms that support the wires would project into the center of the street. After a careful analysis of the visual impact of wires and fixed guideways in various parts of the study area, it was concluded that the general effects of an overhead structure in the residential areas of Old Town would be so severe that consideration of such a system for the whole study area was precluded. This decision was substantiated by a survey in which different transit system concepts were presented to community groups, merchant associations, and the historic area committee.

### Technological Analysis

Over the past 5 years, many new forms of urban transportation have been developed that include a number of small-scale transit systems for the distribution of passengers over small areas. The advantages and disadvantages of these systems were weighed. These systems were then compared to more conventional forms of transit-distributor systems (6).

The three transit possibilities analyzed were people-mover, light rail, and bus systems. The advantage of people-mover systems and elevated guideways is the ability to carry large volumes of passengers at relatively

**Figure 1. Systems evaluation matrix.**

| Objectives | 1 Fixed Guideway Systems: A Headway Systems (Medium capacity) | 1 Fixed Guideway Systems: B Demand-activated PRT (Low capacity) | 2 Specialized Bus Systems | 3 Light Rail Systems |
|---|---|---|---|---|
| 1. MINIMIZE VISUAL INTRUSION | ☐ | ☐ | ■ | ◪ |
| 2. Minimize air pollution | ■ | ■ | ☐ | ■ |
| 3. Minimize energy consumption | ☐ | ☐ | ■ | ◪ |
| 4. Reduce auto traffic congestion | ◪ | ◪ | ◪ | ◪ |
| 5. Enhance Alexandria's image | ? | ? | ? | ? |
| 6. Maximize ease of travel | ■ | ■ | ■ | ■ |
| 7. Minimize land for stations/structures | ☐ | ☐ | ■ | ■ |
| 8. Minimize land for parking etc. | ■ | ■ | ■ | ■ |
| 9. Encourage development in defined corridors | ■ | ■ | ◪ | ■ |
| 10. SYSTEM CAPACITY COMMENSURATE WITH PEAK DEMAND | ☐ | ◪ | ■ | ◪ |
| 11. Maximize wide-area service | ☐ | ◪ | ■ | ☐ |
| 12. Minimize on-system time | ◪ | ■ | ☐ | ☐ |
| 13. Maximize route flexibility | ☐ | ☐ | ■ | ☐ |
| 14. Minimize vehicular conflicts | ■ | ■ | ◪ | ☐ |
| 15. Maximize system reliability | ◪ | ◪ | ■ | ◪ |
| 16. Minimize operating costs/fares* | ◪ | ◪ | ☐ | ☐ |
| 17. Minimize capital costs* | ☐ | ☐ | ■ | ◪ |
| 18. Minimize physical problems of integrating system into area | ☐ | ■ | ■ | ■ |
| 19. Maximize personal Security | ◪ | ☐ | ■ | ■ |
| 20. Provide pleasant riding environment | ■ | ■ | ◪ | ◪ |

■ Very Good
◪ Satisfactory
☐ Poor

*Specific costs will be developed in Phase II of the study.

high average speeds with minimal labor cost. The major disadvantages are the visual impact of the guideways, the relatively short experience of operating in commercial situations, and high capital costs.

The advantages of light rail systems are clean, nonpolluting operation, undefinable charisma of the vehicles, and ability to operate relatively well in a semi-reserved street right-of-way. The disadvantages are similar to those of an elevated guideway system, with the exception that the overhead structures are less obtrusive. The light rail systems also require manual operation. The ubiquitous bus has achieved its prominence by being relatively cheap to install, flexible to operate on a variety of routes, and able to penetrate most areas where the automobile can go with minimal visual impact. On the other hand, buses have polluting engines, must operate in mixed traffic (although special bus lanes can be created), and require manual operation.

## Evaluation Criteria

As a part of the evaluation process, each of the three systems was described according to a set of factors that included operating characteristics, physical features, use of resources, and environmental impact. Under the elevated guideway system, two subsystems, namely Medium Capacity Headway System and Low Capacity Demand Activated PRT System, were considered in the evaluation matrix.

The information developed was a major input to the overall system evaluation process. Each type of vehicle was assigned a rating to indicate whether it satisfied an objective well, moderately, or poorly. Because of the disparity among the objectives, between those that were suited to quantitative and qualitative evaluation, this broad qualitative rating system was applied as the lowest common denominator.

A comprehensive set of objectives was developed that encompassed transportation planning, community urban design, and operational aspects of the proposed system. The system evaluation process indicated that the majority of the objectives were totally satisfied by a small bus system, and that only three objectives were not satisfied. As shown in Figure 1, these objectives were air pollution, length of travel time, and operating costs.

It was concluded that all further analysis in this study should be in the area of small bus systems. This conclusion presents a wide range of options from the twin coach models to the articulated minibus; from the conventionally powered diesel bus to the battery-operated Electrobus; and from the rear-engined Flexette to the low-platformed, front-wheel-drive Ginkelvan.

## CONCLUSIONS

1. The range of demand indicates that there are sufficient trips to justify a minitransit system in the central area of Alexandria under all foreseeable circumstances of growth to 1992.
2. A small fleet of minibuses is well suited to accommodate the 30 000 to 40 000 daily trips that are anticipated by 1992. Even the highest peak-hour volumes in 1992 do not justify the fixed guideway system.
3. The initial public reaction supports the view that a fixed, elevated guideway would be incompatible with the historic and residential environments of the study area.
4. Depending on the modal-split assumptions, between 18 and 30 small 25-passenger buses will probably be required to satisfy peak-hour demand. This demand will allow between 90 and 60-s headways respectively. These figures are tentative and will be subject to more rigorous scrutiny in phase 2 of the study when operations, schedules, and costs will be analyzed in more detail.
5. The ultimate selection of a minitransit vehicle should give strong weight to considerations of comfort, pleasant interior design, and particularly the attractiveness of the vehicle as it contributes to the city streetscape.

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REFERENCES

1. Comprehensive Plan. Alexandria Department of Planning, Alexandria, Va., 1971.
2. S. Khasnabis, J. G. Pickard, and W. E. Mann. A Transit Distributor System for Downtown Alexandria. Paper presented at the 3rd Inter-Society Conference on Transportation, Atlanta, July 1975.
3. W. E. Mann. TRIMS Model for Suburban and Quick Response Transportation Planning. Paper presented at the Urban Transportation Planning Computer User's Seminar for the Federal Highway Administration, Scottsdale, Arizona, May 1974.
4. The Circulation of People in the St. Paul Central Area. Barton-Aschman Associates, Inc., March 1974.
5. Traffic Revenue and Operating Costs. W. C. Gilman and Co. and Alan M. Voorhees and Associates, Inc.; Washington Metropolitan Area Transit Authority, Feb. 1970.
6. N. D. Lea. The LEA Transit Compendium. Transportation Research Corp., Vols. 1-7, 1974.