

Title: "Grand River Avenue Transit Survey -- Detroit, Michigan" (Final Report)

Author: City of Detroit, Department of Street Railways

Date: January, 1963

Proj. #: MICH-MTD-1

Keywords: 1. Surveys
2. Community Response
3. Qualitative Analysis
4. Ridership, attraction
5. Trip Generation

Abstract: Declining patronage and rising costs made it imperative for the Department of Street Railways of the City of Detroit to study any means by which the number of people using their transit facilities might be increased. Suggestions of fare reductions, increased service, better equipment, and public information programs were frequently offered as possible solutions. Transit service companies can increase patronage through reduced fares and improvements in service and equipment, but the cost to the companies is not offset by increased patronage. In addition, there has been no accurate measurement of the results obtained from using any of the above mentioned methods; the cost of all such programs has precluded their widespread usage over a period extensive enough to induce new patronage and measure the results.

The Department of Street Railways scheduled a fairly large-scale pilot study of the effect of service increases on one of its major lines (The Grand River Line) to determine the extent to which passenger usage is affected by the frequency of service on a given line, and to measure the effect of improved transit service on other traffic using the street.

This report is divided into sections which deal separately with the various phases of the project, the different increases and improvements of service during the study period, the difficulties involved in maintaining the changed services, the types of surveys and interviews taken of the public, and the results and findings derived from the surveys. Also, included in the report are descriptions of the different types of passengers. The report emphasizes the community's response to the survey itself and the efforts of the Department of Street Railways to increase patronage of public transportation.

NTIS Order #: PB-174-416
PC \$6.00, MF 95¢

Title: "Fare Structure: Design, Implementation and Evaluation -- Technical Report #2"

Author: American Academy of Transportation

Date: June, 1970

Proj. #: MICH-MTD-2

Keywords: 1. Bus, commuter
2. Fare, cost determination
3. Surveys
4. Market Research
5. Routes and Routing
6. Intermodal Competition

Abstract: The report outlines development of a fare structure for the Maxi-Cab demonstration project in Flint, Michigan. Previously the City's public bus transit system was characterized by declining patronage and rising costs which could not be met through fare-box revenues alone. The Maxi-Cab concept was applied in an attempt to redress this trend by offering an attractive and economical alternative to commutation by private automobile. The authors note in their introductory text that fare structure was therefore considered a principal aspect of the overall marketing program.

As a first stage in determining fares, the authors conducted a thorough cost analysis of bus transit in the region. "Cost floors" were developed which reflected minimum revenues necessary to support different levels of service. An estimate of total operating costs was derived by projecting the ratio between each operational function (eg. maintenance, administration, equipment) cost and mileage.

The authors also conducted market research surveys to determine the probable value of Maxi-Cab service to its prospective customers. This analysis covered both quantitative (eg. daily work trip costs) and qualitative (eg. attractive features of private transportation which could be offered by Maxi-Cab) variables. The authors stressed point-to-point service and reduced costs of Maxi-Cab in their interviews with random workers at major area trip generators. The report concludes that immediate market potential for the special bus service would cover up to one fourth of all area employees. In addition, it was learned that nearly three persons in four spent upwards of \$4.00 weekly for transportation and that 81% would support Maxi-Cab if fares were held to 71¢ the round-trip.

Data collected during the cost analysis and market research stages were compared with proposed routes for the Maxi-Cab to delineate viable fare zones within the project area. Four fare zones were developed based on the distance of route segments from their respective destinations. A graduated fare structure was then fashioned within the zonal system. Fares are computed on a daily and monthly basis and reveal costs that compare favorably with private transportation for persons traveling three or fewer miles to work. Appended material documents additional data and procedural aspects for market analysis.

NTIS Order #: PB-198-059
PC \$3.00, MF 95¢

Title: "Data Plotting and Analysis , Origin Destination, Technical Report No. 4"

Author: American Academy of Transportation

Date: June, 1970

Proj. #: MICH-MTD-2

Keywords: 1. Trip Generation
2. Survey

3. Routes and Routing
4. Demand-Responsive Systems

Abstract: The purpose of this technical report was to explore origin-destination analysis as it was applied in the Maxi-Cab Commuter Club Program of Flint, Michigan.

In order to fully analyze the potential demand for service, data on each hourly and salaried employee working in the larger traffic generators were necessary. Project officials determined, on the basis of the number of employees, that the six General Motors plant complexes (employing over 75,000); the two hospital complexes (employing 3,700); and the central business district area (4,200 shop, office, and governmental employees) should be reviewed as potential customers. Specific data were requested from each selected group's personnel office. These data included each employee's name, address, shift start-quit times, plant where employed, and plant entrance nearest his work station. To effectively analyze the origin-destination data a visual display of the locations of the residences of workers with common shifts was required. Each employee's residence was plotted upon a map which was mounted on a fiber board. The maps covered the Flint Transportation Authority's service area--the city of Flint and a two-mile perimeter--and color coding indicated the groups of plant entrance gates nearest an employee's work station. These displays were, in effect, instant origin-destination studies. After the origin-destination data were obtained and plotted, this information was used to plan the routing for the special purpose door-to-door bus service, Maxi-Cab.

The authors recommended that specific origin-destination survey and analysis be conducted in conjunction with all technical study grants. This type of data can provide the basis for the determination of a mix of services and the establishment of demonstration programs. In Flint, for example, initial analysis indicated that Maxi-Cab service would be highly successful because of the large concentration of workers in the General Motors' complexes. Following the completion of the origin-destination analysis, it was discovered that, instead of being clustered in high-density neighborhoods, workers were actually scattered throughout the city. This, of course, would increase the collection-delivery times and make this type of service more difficult in Flint than in a more composite city.

NTIS Order #: PB-196-774
PC \$3.00, MF 95¢

Title: "Transportation and Central City Unemployment"

Authors: Edward D. Kalachek and John M. Goering (Washington University)

Date: March, 1970

Proj. #: MO-MTD-2

Keywords:	1. Employment	5. Industrial and Labor Relations
	2. Poverty	6. Suburbs, business districts
	3. Inner City	7. Bus, commuter
	4. Race	

Abstract: The report examines central city unemployment patterns and the utility of transportation-oriented programs designed to promote mobility to suburban job opportunities. The St. Louis metropolitan area was a selected case study. The purpose of the report was to test the belief that improved city-to-suburb transit services would make employment available to "hard-core" unemployed. A fundamental premise of this central hypothesis is that the suburbs are attracting considerable new industrial potential, and that an effective urban employment program must make these opportunities available to immobile inner city dwellers.

The authors attempt to refute the "transportation bottleneck" thesis (ie. that lack of adequate transportation deprives inner city residents of the mobility necessary to obtain jobs) in several ways. First, they note that recent census data have indicated that the creation of blue-collar employment opportunities in the suburbs has been largely offset by movement of urban Negroes into these areas. Second, suburban employers did not indicate a shortage of unskilled or semi-skilled labor. Thus, even where transportation services could provide access to job opportunities for the hard-core unemployed, the availability of such jobs would be questionable. Third, the authors suggest that the chronically jobless population may be small, and that survey samples of inner city Negroes indicated unemployment spells averaging only 2.6 months in three years. The report also notes that hard-core unemployment as defined is highly variable according to the national labor market. The overall availability of jobs proved very elastic between 1958 and 1969, indicating that a transportation-employment program may be affected by labor market conditions beyond its control.

The authors also examined Negro unemployment patterns and conclude that high rates of joblessness seemed more the result of frequent job turnovers than an inability to find work. This problem is discussed with reference to transportation programs. The authors conclude that given current levels of job availability, employment patterns among the inner city poor, and management attitudes in industry, the utility of such programs may be questionable. The report notes particularly that transportation programs fashioned within existing conditions would be economically prohibitive.

The authors also developed several questionnaires and other survey instruments with which to evaluate future transportation-employment projects. These would be disseminated among both management and potential workers to determine the likelihood of job openings, occupational requirements, and employee characteristics.

Appended material includes: (1) location of residences and employment in 1960, (2) a preliminary report on the effect of transit improvement on employment, (3) job hunting patterns of the unemployed poor, (4) an evaluation scheme for transit improvements, (5) a survey of suburban manufacturing plants, (6) "Negro ghetto labor market surveys", (7) results of the TEMPO experiment, (8) a survey of contemporary literature in the area, and (9) job tenure in a typical St. Louis factory.

NTIS Order #: PB-192-493
PC \$3.00, MF 95¢

Title: "Shuttle Bus Service, Hunters Point Avenue to Manhattan: Final Report"

Author: Wilbur Smith Associates

Date: March, 1968

Proj. #: NY-MTD-5

Keywords: 1. Bus, feeder
2. Routes and Routing
3. Schedules and Scheduling
4. Fares
5. Budget and Budget Planning
6. Trip Generation
7. Financing Mass Transportation, requirements

Abstract: The report discusses the public transportation system from Queens and Long Island to Manhattan via the Long Island Rail Road Service, Hunters Point Avenue Subway, and Hunters Point Avenue Rail Road. The unsafe and inadequate platforms at Hunters Point Station and the overcrowded conditions of the transportation facilities prompted this study which sought new concepts for local passenger operations.

As a result, in February, 1965, the Hunters Point Shuttle Bus demonstration project commenced and extended for 17 months. The shuttle buses from the Manhattan and Bronx Surface Transit Operating Authority provided quick and convenient connections for approximately 3,500 daily commuters between the Long Island Rail Road Terminal at Hunters Point Avenue in Long Island City and the employment center of East Side Mid-Manhattan. This service paralleled subway transportation on the IRT Flushing Line to achieve closer coordination between rail and bus modes.

One unique characteristic of the Hunters Point Shuttle bus, serving only Manhattan-bound commuters in the morning and Queens-bound passengers in the evening, is that it required an unusually long deadhead run. To return to its starting point, each bus had to travel some three miles without passengers since no significant travel demand existed in the direction opposing the heavy commuter traffic. In view of this, the Hunters Point Avenue shuttle buses carried revenue passengers on less than 50 percent of the overall routing.

The fare for this type of bus service was \$0.15, being the predominant charge on most transit facilities in New York City in 1965. The implication of this, however, was that revenues collected on the shuttle buses would result in a revenue loss to the subway, since most bus riders were diverted from the IRT Flushing Line. The additional service had to be provided without prospect of a corresponding revenue increase, implying it would be a deficit operation from the beginning.

In conjunction with the new shuttle bus service, expenditures of almost \$100,000 were made to improve the passenger platform at the Hunters Point station by extending its length about 500 ft. This enhanced safety of passengers and has contributed substantially to a more efficient station operation, effecting transfer of passengers from the Long Island Rail Road to both the bus and the IRT Flushing Line.

In early April, the New York City Transit Authority announced that it could not continue the line after April 15, 1966, without Federal or local financial assistance; a three month extension was granted following a wave of protests from commuters. However, because of lack of interested local private bus operators, coupled with a daily operating deficit, the shuttle bus was discontinued by decision of a hearing held on July 15, 1966.

NTIS Order #: PB-183-162
PC \$6.00, MF 95¢

Title; "The Queens-Long Island Traffic Demand Model"

Authors: Peat, Marwick, Livingston & Company

Date: April, 1968

Proj. #: NY-MTD-5

Keywords:	1. Computer, application	6. Ridership, volume
	2. Computer, programming	7. Access, planning and control
	3. Traffic, analysis	8. Routes and Routing
	4. Traffic, flow	9. Traffic, peak-period
	5. Modal Split	10. Trip Generation
		11. Demography

Abstract: The purpose of this report was to describe the analyses, model development, model validation, and test applications utilized to develop and apply a traffic demand model capable of providing realistic estimates of travel on all major travel facilities serving the Queens-Long Island sector of New York.

The traffic model is a mathematical method, programmed for operation on an electronic computer, which allows the estimation of trip interchange volumes between travel analysis zones in the study area, and the assignment of these trip volumes to travel facilities to produce estimated flows of persons and vehicles in present and future years. The model is comprised of four elements: (1) determination of travel routes and accessibilities; (2) trip generation and modal split--calculating the total number of trips departing from, and arriving at, each traffic zone; (3) the calculation of the number of trips between each pair of traffic zones in each direction via the four major travel modes; and (4) production of estimation flows of persons and/or vehicles on each link in the networks for each of the four major travel modes: the Long Island Railroad, subway, bus, and automobile.

The traffic model was validated by applying it for the 7 a.m. to 10 a.m. morning peak period traffic of a typical weekday in 1964 and comparing the results with the observed traffic counts carried out during 1963 and 1964 on the rail, subway, bus, and highway facilities serving the study area, and with information from origin-destination surveys.

The authors concluded that the Queens-Long Island Traffic Model is sensitive to the major factors that influence travel demand for relevant travel modes in the Queens-Long Island sector. Estimated by the model, interzonal trip volumes are dependent upon the resident labor force, median family income, and employment density in the zone of origin. These volumes also depend upon the relative attractiveness of destinations as measured by their employment levels and the travel time, cost, and convenience separating each destination from the origin zone. Model development and testing carried out to date indicate that improvements in its reliability might be achieved by incorporating new sources of data and simulation techniques not originally feasible because of study timing and other limitations. The possibility of tracing multiple routes between zones, using an origin-destination modal split technique, and considering high load factors and the inconvenience of transferring, might produce an even more refined product.

NTIS Order #: PB-183-193
PC \$6.00, MF 95¢

Title: "VIP Transportation -- Extending Urban Mass Transportation in a Typical Small City (Final Report)"

Author: City of Rome, New York

Date: March, 1969

Project No. NY-MTD-6

Keywords: 1. Bus, design
2. Small Cities
3. Trip Generation
4. Private Transportation, automobiles
5. Advertising and Promotion
6. Community Response

Abstract: The report summarizes a demonstration of "VIP" bus transportation, designed to serve the specific population and economic characteristics of Rome, N.Y. The project employed a system of small bus vehicles operating with fixed routes and schedules which were designed to attract ridership from private automobiles, alleviate traffic and parking congestion, and stimulate the revitalization of Rome's central business district.

All relevant aspects of the demonstration project are examined with reference to background, planning, operations, market studies, and post-project developments. The VIP service was instituted with three basic premises: (1) that conventional, large-vehicle bus service could not effectively compete with automobiles in relatively small urban areas; (2) that an intensive public relations program would be needed in conjunction with the special bus service; and (3) that home-to-work routes could be successfully developed and implemented.

The VIP service employed specially-designed, 20-passenger vehicles which were intended to portray an unconventional transit image. The buses were operated during the day in a hub/spoke routing network designed to minimize foot travel and to permit as near point-to-point service as possible. The authors particularly emphasize the importance of continuing marketing and promotional activities which were necessary to attract and sustain patronage.

Although the VIP system showed a steady rate of growth in terms of passenger usage and revenue, the demonstration indicated that a bus system in Rome requires subsidization. Ridership surveys revealed that the service was used most frequently for shopping trips in the central business district and outlying shopping centers. VIP riders were primarily transit "captives" who lacked access to private automobiles (eg. low-income and elderly persons). Significantly, attempts to attract persons having such access to automobiles (especially working commuters) were unsuccessful. Nevertheless, the VIP service has been continued as a public service.

NTIS Order #: PB-191-669
PC \$3.00, MF 95¢

Title: "Two-Way Radio Communication Mass Transportation Demonstration Project"

Author: New York City Transit Authority

Date: Undated

Proj. #: NY-MTD-8

Keywords: 1. Communications
2. Crime and Crime Prevention
3. Rail, systems planning and design

Abstract: The report summarizes a demonstration of two-way radio communications for use in the New York City subway system. The project was conceived in response to a need for instantaneous communication between motormen and train controllers and between transit policemen and their headquarters. Existing equipment prior to the demonstration required that train crews descend to the tracks in order to report trouble; police had to rely on conventional telephones available only in station clerks' booths. The objective of the project was therefore to develop and test mobile communications equipment adapted to the special conditions prevalent in an urban subway system.

A variety of alternative systems and components were considered, including various train-to-wayside intercom systems currently used in Chicago, Toronto, and London. The authors note that these were too limited in scope for the complex New York City subway network, and that a portable transistorized transmitter/receiver was judged ideal, particularly for the policemen who required compact, durable equipment. The report documents in detail the engineering, operation, and maintenance of the selected system, including the development of miniaturized transistor components. Textual analysis is supplemented by engineers' schematic drawings and other graphic illustrations.

The improved communications were evaluated primarily in terms of reduced train delays and police reaction time. The latter was demonstrated to be particularly effective. Message delays between police dispatchers and transit patrolmen were reduced by 99%, and the ratio between crimes and arrests improved by 8% during daylight hours and rose to 95% at night. Overall operational efficiency also showed substantial improvement. The average number of train delays per month decreased 41% and the average duration of such delays decreased 9% in the test area as compared with the system as a whole. Ridership within the test area was also shown to increase during the demonstration. The authors concluded that overall, the project was successful enough to warrant the use of two-way radio equipment throughout the New York subway system.

Two appended sections document capital and overhead costs for the project, and requirements for extension of the system to other divisions of the subway network.

NTIS Order #: PB-177-048
PC \$6.00, MF 95¢

Title: "The Effect of the 1966 New York City Transit Strike on the Travel Behavior of Regular Transit Users"

Author: New York City Transit Authority

Date: Undated

Proj. #: NY-MTD-9

Keywords: 1. Industrial and Labor Relations 6. Private Transportation, taxicab
2. Surveys 7. Private Transportation, automobile
3. Ridership 8. Intermodal Competition
4. Time Costs 9. Trip Generation
5. Rail, commuter 10. Modal Split
11. Bus, commuter

Abstract: The purpose of this study was to obtain a factual picture of the effects of the New York City transit strike on regular transit users so that planning and evaluation of New York City Transit Authority programs could be guided to better serve the public. The research was directed toward the behavioral reactions of the public, excluding specifics regarding any economic losses other than trip costs.

This report provides a basis for determining the effects of a disrupted transit service of great magnitude for an extended duration and indicates the difficulties inherent in making contingency plans for a potential major disruption of transit service. It also provides planning insight on the importance of introducing a mass transit system to new areas. What happens to transit system riders as a result of an involuntary disruption of their regular travel habits is discussed along with voluntary diversions caused by fare increases or service changes.

Survey data were obtained from household workers and home interviews with transit users to determine: (1) pre-strike travel patterns, (2) effects of the strike on the public, (3) adaptations of the public in the absence of normal transit services, and (4) patterns of diversion from pre-strike patterns. Within these four categories, further analysis was made to reveal where applicable: trip purpose, length and cost of trip, age, income, occupation, and location of residence. The survey plan called for interviewing a minimum of 8,000 regular transit users, who are defined as ones who use the system at least three times per week.

Patterns of travel during and after the strike were obtained. Nine in ten of those who stopped using the system had continued working during the strike. The number of modes attempted matched the total worker pattern, but more automobile travel and walking took place during the strike on the part of those who ultimately gave up using the bus or subway.

Post-strike modes of travel to work closely matched the first mode of travel during the strike, suggesting that a new habit had been created. Those who had come to work by employer-arranged bus reverted to using their own cars after the strike. In fact, two out of three of those who stopped using the mass transit system drove to work and over half of the entire group drove in their own car.

After the strike, 2.6% of those who previously used the transit system regularly for shopping had stopped using the bus or subway. Over half of these now walked and the remainder used a car or taxi. Furthermore, 2.4% of those who used the transit system regularly for some purpose other than work or shopping, stopped using the bus or subway. Car and taxi were now being used with a large group not specifying a particular new mode. Evidently, in the area of discretionary trips made for non-work and non-shop purposes, the modal habitance changed is subject to more diversity and irregularity.

NTIS Order #: PB-175-764
PC \$6.00, MF 95¢

Index No. 1-NY-9.1

Title: "The Merrick Minibus: A Small Feeder Bus Operation for Commuters"

Author: Town of Hempstead, N. Y.

Date: May, 1971

Proj. #: NY-MTD-11

Keywords:	1. Bus, commuter	7. Fare, cost determination
	2. Bus, minibus	8. Youth
	3. Bus, feeder	9. Suburbs, business districts
	4. Rail, commuter	10. Advertising and Promotion
	5. Interfaces	11. Community Response
	6. Fare, collection	12. Financing Mass Transportation, requirements

Abstract: The report summarizes a demonstration project designed to test the viability of a small, inexpensive commuter bus service in an area of low population density. The project objectives included reducing the need for expanded parking facilities and alleviating traffic congestion. The project also sought to eliminate the need for local railroad commuters to own second or station cars and to test non-peak period patronage in terms of profitability. The minibuses used in the demonstration were dispatched to meet commuter trains at the Merrick Long Island Railroad station, and served the Merrick business district during off-peak hours.

The report examines all aspects of the demonstration project. Procedures employed in selecting an appropriate transit bus are discussed, including vehicle specifications and amenities for passenger comfort. The service operations over a two-year period are thoroughly documented. Fiscal operations are also detailed, with particular emphasis upon fare determination, operators' wages, fare collection, and avoidable costs.

A detailed discussion of impact on the project area includes the results of periodic on-board interviews and questionnaires. Publicity promotion and public relations are also outlined in detail with specific illustrations of advertising in the mass media.

After two years, the project sponsors concluded that the Merrick Minibus was not sufficiently profitable as a commuter service to warrant continued operation. Although the the Monday-Friday schedules were suspended, a well-patronized Saturday service was maintained indefinitely. Four distinct findings are advanced: (1) The feeder bus service to Long Island Railroad did not attract enough passengers to become profitable. The authors note, however, that profitability may be less important than the willingness of a community to subsidize such specialized service. (2) Consistently high patronage of the project service by young people indicated a potentially untapped market for transportation. Provision of such services was estimated to be at least a break-even undertaking. (3) The Merrick area was characterized by low density, a lack of convenient collector points, and numerous curvilinear streets which tended to disburse potential riders. The authors suggest that the design of new suburban communities may be altered in these respects to increase their potential for mass transit. (4) The availability of a second car to many Merrick households was a significant factor in reducing patronage, suggesting a direct correlation between affluence and transit demand.

NTIS Order #: PB-200-136
PC \$3.00, MF 95¢

Title: "An Air Conditioning Study of the New York City Transit System -- Part I:
A Thermal System Model and Equipment Valuation"

Author: General Electric Company Research and Development Center (for New York
City Transit Authority)

Date: Undated

Proj. #: NY-MTD-12

Keywords: 1. Air Conditioning 5. Rail, stations and terminals
2. Cooling Systems 6. Ridership
3. Rail, rolling stock 7. Computer, applications
4. Rail, system planning and 8. Quantitative Analysis
design 9. Underground Structures

Abstract: The report summarizes a study of air conditioning alternatives for the New York City subway system. The primary objective of this study was to determine an optimum method for cooling both trains and stations under a variety of conditions to provide greater passenger comfort. Initial considerations are outlined including characteristics of alternative cooling systems and the cost-comfort trade-off.

Methodology for the study is described in detail. One particular problem was that the complex nature of the City's subway thermal system precluded simple demonstration of the alternative systems. Consequently a mathematical model of the thermal characteristics of a subway segment was developed as a tool for performance evaluation of proposed cooling systems. The model was programmed for a high-speed digital computer, and operational data for several air conditioning designs were analyzed against a list of comfort and performance criteria.

Among the principal findings were: (1) that vapor compression air conditioning was the best system for cooling subway cars; (2) that large fans could provide sufficient nighttime station ventilation; and (3) that for new stations, large, centrally-located absorption cycle refrigeration units would best provide immediate-area cooling as well as ventilation for adjacent stations. The study also revealed that subway ventilation was the most important factor affecting passenger comfort.

Recommendations for future RD&D in the field of subway cooling and for the application of existing technology in future subway construction are noted. Two appendices provide thorough documentation of cost analysis for the cooling systems considered.

NTIS Order #: PB-196-362
PC \$3.00, MF 95¢

Title: "Air Conditioning Study of the New York City Transit System -- Part II: Feasibility of a Thermoelectric Air Conditioner for Subway Cars" (Final Report)

Author: Westinghouse Electric Corporation, Transportation Division (for New York City Transit Authority)

Date: Undated

Proj. #: NY-MTD-12

Keywords: 1. Air Conditioning
2. Brakes and Braking, Dynamic
3. Brakes and Braking, Regenerative
4. Kinetic Energy
5. Rail, Rolling Stock
6. Power Distribution

Abstract: The report focuses on feasibility and cost aspects of thermoelectric air conditioning for subway cars in the New York City transit system. The proposed thermoelectric configuration was devised to minimize third-rail power consumption and to convert the kinetic energy otherwise dissipated during dynamic braking into an efficient power source for vehicle refrigeration. The study focused on two basic aspects of the design: (1) cooling load requirements, and (2) feasibility of the unit.

Cooling load requirements were calculated for the standard 200-passenger car at normal tunnel conditions. It was determined that the maximum refrigeration capacity necessary was 19 tons of air conditioning to satisfy pre-determined levels of passenger comfort. The authors note that such comfort considerations are a primary determinant of ridership on the subway system during summer periods of peak cooling demand. Detailed cooling-load analysis is appended.

The thermoelectric air conditioner studied was designed to convert available dynamic braking energy into a viable power source for refrigeration. This proposal was believed to be particularly desirable because it would potentially minimize energy and capital costs and because it would reduce thermal power emissions into the tunnel. The analysis thus focused initially on the power available from regenerative braking circuits. Unfortunately, the authors concluded that brake energy is dissipated not at a central source, but through several resistors not all of which produce power available to the air conditioning unit. Therefore, somewhat less than the total amount of kinetic energy could be employed to power the cooling system, and the authors calculate that overall (given 100% efficiency), only 13 tons of air conditioning could be provided by this power conversion method.

Efficiency of the refrigeration unit was measured by a coefficient of performance (COP) which delineates the ratio between cooling effects produced and power consumed. The most economical thermoelectric air conditioner chilled water during the braking period and circulated it through a continuous coil. However, the COP for this unit was extremely low and was calculated to provide less than 1/3 of the cooling requirements determined earlier. It would therefore become necessary to supplement the system with conventional vapor-compression equipment which draws power from the third-rail. A variety of thermoelectric and vapor-compression configurations were analyzed.

The report documents all relevant data for braking, braking currents, power generation, and costs along with a brief outline of instrumentation and measurements. The authors conclude that savings generated by the thermoelectric unit's use of braking energy would be more than offset by the costs of developing the combination system. The report therefore recommends discontinuation of plans for future design and testing of the thermoelectric air conditioner for subways.

Title: "Track-Sharing for Urban Transportation"

Author: Institute of Public Administration

Date: January 30, 1970

Proj. #: NY-MTD-13

Keywords: 1. Dual-Mode Systems 6. Traffic, analysis
2. Center City 7. Schedules and Scheduling
3. Tracks and Trackage 8. Signs and Signals
4. Wheels 9. Industrial and Labor Relations
5. Financing Mass Transportation, 10. Government, Federal
sources

Abstract: Track-sharing means, generally, the imposition of additional functions or usages on existing railroad trackage. This report restricts it to urban transportation, primarily of passengers. The substantial vehicle development in railbuses is also reviewed.

Due to the increased population, automobile usage and highway congestion, interest has increased in the use of existing unused interstate railroad trackage to expand metropolitan area transportation.

The report discusses three potential alternative uses of railway tracks for urban passenger transportation. One is to reinstate the train service or add new service, referred to as a Conventional Service. However, the author points out that these services have much higher operating costs than collectible revenues, requiring a subsidy. Secondly, the bulk of this report describes current developments for adapting standard diesel transit buses to operate on both railways and highways. It also reviews preliminary studies of the application of these vehicles to specific transportation needs in seven metropolitan areas -- Hartford, New York City, Philadelphia, Miami, Cleveland, Minneapolis, and Washington, D. C. The third alternative is the conversion of the rail right-of-way to other uses such as busways. This approach usually proposes to retain the restricted access feature of railway operation and to pave over the right-of-way for priority use of the transit buses providing the same service as railbuses.

For each of these alternatives problems are raised and analyzed in this report.

The findings on potential railbus use, track availability, selection of useful tracks vehicle development, operating problems, costs of the service, and institutional problems are presented.

The report concludes that a railbus vehicle which can provide an improved urban transportation service at a comparatively low cost could be available with modest additional development outlays. However, the various institutional problems are sufficiently serious so that they could restrict the use of many possible trackage and thereby limit the possibility of achieving all the economies possible.

It is recommended that railbus service is sufficiently promising and its potential costs are so reasonable that it is worth some additional effort and investment by UMTA to finally dispose of the question of the feasibility of its scope of application.

The author stresses that projects undertaken by UMTA should have three major objectives: (1) to attempt to resolve the institutional problems by regular scheduled operation; (2) to complete vehicle development and prepare solutions to problems of intermixing with other rail traffic; and (3) to test the market for this type of service improvement. Guidelines are set forth for the UMTA demonstrations by the authors.

NTIS Order #: PB-192-784
PC \$3.00, MF 95¢

Title: "Demand-Actuated Road Transit (DART): Performance and Demand Estimation Analysis"

Author: The Institute of Public Administration and Teknekron, Inc.

Date: March 15, 1969

Project No. NY-MTD-16

Keywords: 1. Demand-Responsive Systems 7. Vehicle, monitoring
2. Trip Generation 8. Off-peak Traffic
3. Bus, cost 9. Traffic, analysis
4. Site Selection 10. Traffic, peak-hour
5. Routes and Routing 11. Fare, cost determination
6. Private Transportation, taxicabs 12. Quantitative Analysis

Abstract: The report describes the Demand-Actuated Road Transit (DART) system and analytic techniques to aid in site selection for demonstrations of the concept. DART is a demand-responsive bus transportation system which provides direct point-to-point service in a variety of urban situations. The system employs a fleet of small bus vehicles which are dynamically routed by computer. Telephoned service requests from customers are processed to determine optimal routings based upon proximate origins and destinations. In this manner, the concept operates something like a group taxicab. The DART system may also be used in conjunction with automatic vehicle monitoring.

The authors emphasize flexibility of the DART concept with reference to fare structure, service level, and operations. In small or medium sized cities, the DART may fulfill all transit requirements; elsewhere the system may be employed to supplement conventional linehaul bus service or as a low cost taxi during off-peak hours. In addition, the DART may be used for: (1) parcel delivery, (2) emergency ambulance service, (3) school busing, (4) shuttle service in high density areas, and (5) charter operations.

A detailed economic analysis revealed probable average operating costs of \$10 per hour per vehicle. Some 60 to 70% of this cost is for labor. A principal aspect of the present report was development of a DART model which would compute the cost per trip as a function of: (1) demand distribution, (2) passenger boarding and unloading time, (3) size and shape of the service area, (4) average vehicle speed, and (5) hourly operating costs. The model permitted any given urban area to be defined by these five variables. The model will prove essential in site selection for a DART demonstration and in determining system feasibility under specific urban conditions. One assumption which guided development of the model was that peak-hour demands tended to place diseconomies on transit operations by concentrating service requests at certain times. The authors therefore investigate several strategies for regulating demand. They conclude that carefully controlled manipulation of DART fares, schedules, and services may facilitate a redistribution of demand to nearly uniform proportions between the hours of 7:00 A.M. and 10:00 P.M.

The authors conclude that DART can best serve as an intermediate transit mode between taxis and regular linehaul buses. In addition, they note that the demonstration service area must be sufficiently large to permit the bus operations to compete favorably with existing public and private transportation modes. Finally, they conclude that the DART would be a feasible candidate for additional development and demonstration; a four-phase program to accomplish these tasks is outlined in detail.

NTIS Order #: PB-189-330
PC \$6.00, MF 95¢

Title: "Bus Design: Concepts and Evaluation"

Author: Rensselaer Research Corporation

Date: 1970

Proj. #: NY-MTD-18

Keywords:	1. Bus, design	4. Quality Control
	2. Bus, cost	5. Vehicle, design
	3. Environment and Environmental Control	6. Demand-Responsive Systems

Abstract: The report is a comprehensive analysis of design components and subsystems for buses. Three basic objectives of the research were to: (1) develop design criteria, (2) evaluate hardware configurations, and (3) synthesize a new prototype design. In their introduction, the authors note that conventional urban bus operations are characterized by declining ridership and rising costs which cannot be met through farebox revenues. A recommended alternative to subsidization under these conditions is a thorough reevaluation of bus operations to provide attractive new services. Standard equipment is not, however, ideally suited to demand-responsive, subscription service, center city circulation, or other innovative applications. The report therefore emphasizes bus design features intended to maximize consumer appeal and operating economies within the demands of these future applications.

Rigorous design criteria were developed for six "vehicle attributes" and compared against nine standard vehicle subsystems and components. The attributes included: (1) passenger comfort, (2) safety, (3) performance, (4) environmental impact, (5) service life, and (6) cost. Subsystems and components were identified as the passenger compartment, driver cockpit, propulsion unit and drive train, suspension and braking systems, environmental control, external configuration, information and communications, fare collection, and total vehicle system integration.

The vehicle evaluation procedure consisted of developing a schema for comparing specific design features on the attribute-subsystem matrix. For each of the design features, equations were derived to measure the extent to which different component specifications added to desired vehicle attributes. The analysis was particularly useful in computing optimum trade-offs between passenger comfort and operating economy. Several alternative interior configurations were analyzed using this evaluative procedure.

Another major consideration of bus design concerns the operational context into which new vehicles must fit. Seven types of service are discussed in detail, each of which imposes different requirements for vehicle design. These include: conventional intra-city routing, base level service, feeder operations, express linehaul service, subscription service, Dial-A-Bus (ie. dynamically routed, demand-responsive service), and major activity center circulation. Three basic conclusions were yielded by the analysis: (1) improved hardware reliability will substantially reduce maintenance costs; (2) smaller bus designs will lower operating expenses and adapt more easily to innovative service applications; and (3) only by offering a totally new design "package" can buses maximize consumer appeal and operating economy.

The report concludes with a comprehensive sample design for a prototype bus applicable in low-density, demand-responsive, or central city circulation service. The vehicle would accommodate up to 24 passengers.

NTIS Order #: PB-203-908
PC \$3.00, MF 95¢

Title: "Cost Analysis Tool for Bus Transit Systems -- Volumes I and II"

Author: Center for Transportation Studies, C.E.N.T.S.

Date: September, 1970

Project No. NY-MTD-18

Keywords: 1. Bus, cost
2. Bus, design
3. Bus, minibus
4. Benefit-Cost Analysis
5. Computer, applications
6. Quantitative Analysis
7. Financing Mass Transportation, requirements

Abstract: The report examines development of a Cost Analysis Tool (CAT) for bus transit operations. The authors note that traditionally, bus companies have countered adverse financial trends with fare increases or the curtailment of public services. Neither approach, however, has effectively resolved the continued erosion of patronage and revenues. In seeking a cost-reduction technique for increasing productivity in the transit industry, the authors note that many systems operating large-capacity vehicles experience inefficient load factors. A basic objective of this report was therefore to test the hypothesis that an integrated system of large and small capacity buses would reduce total operating costs and increase productivity. The authors attempted to develop an analytic tool capable of establishing relationships among the principal vehicle capacity-sensitive cost factors and to apply this tool to explore the feasibility of achieving cost savings for a transit operator by using a mix of small and large vehicles.

The basic concept for this study is based on computing the costs incurred in serving a transit network of known patronage with a fleet of large-capacity buses and comparing these costs with those that would be incurred if the same network and patronage were served by a mixed fleet of various-capacity buses. A four-step approach was employed to validate the assumption: (1) Basic variables and their interrelationships were identified. (2) These relationships were used to develop the structural form for a cost analysis tool. (3) The CAT was validated by comparing the actual performance and costs incurred by a real transit operation [The Wilkes-Barre, Pennsylvania, Transit Company] with those computed by the cost-analysis technique. (4) The same company was then used to compute the costs that would be incurred if that company had operated a mixed fleet of varying-capacity vehicles. Results from steps three and four above were compared in a final evaluation stage.

All relevant aspects of the cost-analysis method are examined in the report with reference to structural analysis, model design, mixed fleet feasibility analysis, and application of the CAT. Appended material expands upon the earlier analysis and includes derivation of the empirical formulae, computer routines for future applications, and other related material.

In the initial CAT application, the authors concluded that although a total of seven additional vehicles would be required for mixed-fleet operations in the Wilkes-Barre metropolitan area, an annual operations cost savings of nearly \$90,000 (or 9.6%) would be realized. The report concludes that the CAT can ultimately be employed to assess the economic impact of technological innovations in bus design, investments in existing transit equipment, service extensions, or financial changes.

NTIS Order #: PB-206-207
PC \$6.75, MF 95¢

Index No. 1-NY-18.2

105

Title: "The J & L Story -- A Manpower/Transportation Demonstration Project, Report Number One"

Author: Cleveland Transportation Action Program (CTAP)

Date: September, 1970

Project No. OHIO-MTD-3

Keywords: 1. Industrial and Labor Relations 5. Financing Mass Transportation
 2. Employment 6. Bus, cost
 3. Routes and Routing 7. Manpower and Personnel
 4. Inner City

Abstract: During Phase I of the Cleveland Transportation Action Program, a special fixed-route, employment-oriented bus service was operated between four inner city neighborhoods and a major employment center, the Jones and Laughlin Steel Corporation plant. This report describes all relevant aspects of the special service and summarizes conclusions of the project.

Under Phase I operations, conventional bus service was provided along two routes for a period of 38 weeks. The buses operated three times a day, seven days a week. Basic objectives of the project were to: (1) improve mobility for the hard-core unemployed, (2) assist them in obtaining jobs, and (3) upgrade the quality of transit service for inner city residents generally. The project was designed to complement the overall Cleveland manpower development program.

Several major findings are summarized in the report. (1) Cooperation between the employer and the manpower agency was found to be paramount in a successful, job-related inner city transportation project. (2) If the transit operation is not publicly subsidized and must depend upon farebox revenues, the industries directly affected by the service are the only logical handoff agencies for the transportation service. (3) Routes serving specific industries should be designed to be usable by all employees -- not just those in inner city poverty areas.

NTIS Order #: PB-196-464
PC \$3.00, MF 95¢

Title: "Downtown Loop Bus Program -- Report #2"

Author: Cleveland Transportation Action Program (CTAP)

Date: October, 1970

Project No. OHIO-MTD-3

Keywords: 1. Routes and Routing
2. Schedules and Scheduling
3. Information Aids
4. Fare, cost determination
5. Trip Generation
6. Signs and Signals
7. Center City

Abstract: The report summarizes the results of two principal demonstration activities -- Santa Loop and Terminal Tower Information System -- undertaken during Phase I of the Cleveland Transportation Action Program. The authors note that a unique aspect of the Cleveland bus network is a set of loop routes that connect major trip generators not easily accessible by walking. Although the loop system has been in existence since 1936, it has become a complex and often redundant system, thus frustrating regular usage by some potential patronage.

The purpose of this research was to design a more viable loop bus system. The demonstration focused upon four basic features: (1) a comprehensive loop bus information system; (2) modifications in the bus route, schedule, and fare structure; (3) a promotional campaign; and (4) installation of new loop bus shelters.

The first action-step in this project was the Santa Loop bus service which tested the attractiveness of an inexpensive (10¢ fares), downtown loop route serving specific activity centers. Results of this experiment were incorporated in a second demonstration at Terminal Tower designed to emphasize new marketing and information concepts. The authors note particularly that the complexity of Cleveland's loop system creates unusually severe requirements for effective passenger information. All aspects of the demonstrations are outlined in detail. The report concludes with comprehensive recommendations for designing bus loop systems.

NTIS Order #: PB-203-785
PC \$3.00, MF 95¢

Title: "Metro Hospital Bus Service Demonstration Project -- Report #3"

Author: Cleveland Transportation Action Program (CTAP)

Date: November, 1970

Project No. OHIO-MTD-3

Keywords: 1. Medical Centers
2. Inner City
3. Routes and Routing
4. Demand-Responsive Systems
5. Trip Generation
6. Fare, cost determination
7. Ridership

Abstract: A special, fixed-route bus service between four inner city neighborhoods and Cuyahoga County Metropolitan General Hospital was operated under Phase I of the Cleveland Transportation Action Program. This report describes the special service and summarizes major conclusions of the project.

Two bus routes were operated between the four inner city neighborhoods and the hospital. Fares were regulated to promote ridership -- 35¢ for adults, 20¢ for children, and 20¢ for "Golden Agers". Various data were collected throughout the project to identify areas for improvement.

The authors conclude that the level of service in such special operations must be specifically tailored to the needs of potential users. The service must therefore be as nearly demand-responsive as possible. The study also revealed that a bus route designed primarily to satisfy one specific trip purpose has very little chance of being an economically feasible solution to the problem. There appeared to be a need for a multi-purpose bus service directly linking the inner city with downtown Cleveland and Metro Hospital.

NTIS Order #: PB-203-786
PC \$3.00, MF 95¢

Title: "Commuter Railroad Service Improvements for a Metropolitan Area - SEPACT I"

Author: Southeastern Pennsylvania Transportation Authority

Date: April 1, 1969

Proj. #: PA-MTD-1

Keywords: 1. Rail, commuter 5. Employment
2. Financing Mass Transportation 6. Schedules and Scheduling
3. Fares, cost determination 7. Routes and Routing
4. Advertising and Promotion 8. Demography

Abstract: The objectives of this project were to: (1) produce transportation findings applicable to other metropolitan areas faced with similar problems; (2) demonstrate the effectiveness of improved service and reduced fares in reversing the ridership decline on commuter railroads; (3) relieve traffic congestion on parts of the region's highway system; and (4) demonstrate the efficiency of a regional approach to common problems. Moreover, the report states its greatest significance lay in its pioneering development of regional cooperation between a large metropolitan city and its surrounding suburbs.

SEPACT I (Southeastern Pennsylvania Transportation Compact) was the first Federally assisted commuter railroad demonstration project in the nation. Southeastern Pennsylvania comprises the City of Philadelphia and four nearby counties with a population of approximately 3.6 million. The anticipated population growth for this area is over one million making this region's transportation critical.

SEPACT I encompassed a combined program of improved service and reduced fares on the Reading Company's North Penn-Hatboro lines and that portion to and from Levittown of the Pennsylvania Railroad's Philadelphia - New York mainline. The program ran for three years and cost approximately 4.7 million dollars. The program included increased service, fare reductions, new equipment, parking improvements, bus-train transfers, and promotion, publicity and information. Other related programs are discussed such as the Passenger Service Improvement Corporation of Philadelphia (PSIC) which was formed to act as management agent for the commuter service program.

The project planning and implementation point out the allocation of responsibilities and special problems affecting the demonstration project.

The author states a prime result of the demonstration was that it helped the Southeastern Pennsylvania Region retain and improve service on a significant portion of its vital commuter rail network, loss of which was threatened. Also the improved service and lower fares brought tangible benefits to commuters in a large portion of the Philadelphia market area.

It is felt that perhaps the most important result is that the successful completion of SEPACT I laid the groundwork for the formation of the Southeastern Pennsylvania Transportation Authority (SEPTA), a regional agency created to integrate the mass transportation facilities of Southeastern Pennsylvania into a balanced system. SEPACT I was instrumental in formulating answers to important transportation questions in improving transportation services on the commuter rail lines.

NTIS Order #: PB-197-346
PC \$3.00, MF 95¢

Title: "SEPACT II Final Report: A Study of the 1975 Commuter Railroad System in the Southeastern Pennsylvania Metropolitan Region"

Author: Southeastern Pennsylvania Transportation Authority

Date: January, 1971

Project No. PA-MTD-4

Keywords: 1. Rail, commuter
2. Ridership, attraction
3. Schedules and Scheduling
4. Management, operations and techniques
5. Advertising and Promotion
6. Fare, cost determination

Abstract: The report summarizes results of a study to determine the optimum 1975 commuter railroad system for the area served by the Southeastern Pennsylvania Transportation Authority (SEPTA). Its major purpose was to develop an action program to maximize rail patronage, principally by increasing the attractions of commuter rail travel vs. private automobiles.

The Southeastern Pennsylvania Metropolitan Region is described in detail with reference to population, employment, land use, and highway development data. The authors also examine the existing SEPTA commuter railroad network which consists of 12 radial corridors. Under the terms of their contracts with SEPTA, two private rail carriers supply approximately 260 route miles of service within these corridors, carrying nearly 120,000 passengers each weekday. Specific characteristics of the existing rail network and operations are summarized in detail.

Based upon various assumptions about the future of regional rail service, the authors developed projections of ridership demand for the year 1975. Eight elements of a proposed action program designed to maximize this potential patronage are examined.

The report focuses particular attention on operational requirements and support facilities for 1975. Specific estimated requirements are delineated with reference to: (1) service standards and passenger amenities; (2) parking facilities; (3) stations; (4) schedules, equipment, and manpower; (5) fare structure; (6) improved rights-of-way; (7) electrification and power distribution; (8) signals; (9) data communications and processing; (10) equipment maintenance; and (11) operations management. The financial implications of these requirements are also discussed in detail along with estimates of costs and revenues for the proposed 1975 system. The report concludes with an outline of program implementation.

NTIS Order #: PB-200-133
PC \$3.00, MF 95¢

Title: "SEPACT III: Final Report -- Operation Reading"
Author: Southeastern Pennsylvania Transportation Authority
Date: June, 1971 Proj. #: PA-MTD-5

Keywords: 1. Rail, commuter 6. Surveys
2. Rail, cost 7. Ridership, attraction
3. Schedules and Scheduling 8. Modal Split
4. Fares, cost determination 9. Advertising and Promotion
5. Fares, reduction 10. Financing Mass Transportation

Abstract: The report summarizes a project designed to develop and test techniques for restructuring commuter railroad service in a major metropolitan area (Philadelphia was the example). Two basic objectives of the demonstration were to minimize operating deficits and to maintain adequate levels of public service. The report notes that in recent years, commuter ridership on the conventional railroad mode has dropped substantially, leading to an unfavorable cycle of fare increases, service deterioration, and, consequently, to further declines in passenger volume. The report summarizes in detail activities carried out under the five-phase experiment, designed to test alternative methods for generating improved service and economy.

Each phase of the experiment tested the relationship between various levels of service, fare structures, and ridership. In some cases off-peak service was increased, in others the total number of trains was reduced. These fluctuations were accompanied by variations in fares, the provision of special passes, and heavy promotional campaigns. Throughout the project, comprehensive surveys were conducted to measure ridership preferences, trip characteristics, and volume. The latter indicated distinct correlations between service levels and demand.

Four general conclusions were yielded by the analysis. (1) Increased service and higher fares were more effective in reducing operating deficits than decreased service and lower fares. This was true because of greater equipment utilization in the former case and the impact of constant overhead costs in the latter. (2) Where service was substantially improved, the data revealed that new ridership was attracted and paid higher fares as well. (3) Greater equipment efficiency resulted in significant reductions in operating cost, thus recommending greater emphasis on capital improvement. (4) The general market for rail service, including commuters, varied substantially over time. The report concluded, however, that certain levels of service combined with commensurate fare structures and promotional campaigns would maximize demand and most nearly satisfy consumer needs.

The authors conclude that rail commuter service was demonstrated to be a viable and integral part of urban transportation, and that, further, levels of service and passenger fares could be provided to ensure a profitable operation. The report notes that its basic conclusions have general applicability to similar rail service in other metropolitan areas. The report also contains complete statistical data and survey results.

NTIS Order #: PB-204-065
PC \$3.00, MF 95¢

111

Index No. 1-PA-5.1

Title: "Mass Transportation in a Small City" (Final Report)

Author: The New Castle (Pennsylvania) Area Transit Authority

Date: Fall, 1968 Proj. #: PA-MTD-6

Keywords: 1. Small Cities 6. Demography
2. Surveys 7. Fare, Reduction
3. Routes and Routing 8. Fare, Cost Determination
4. Schedules and Scheduling 9. Bus, Feeder
5. Ridership 10. Parking, Park-And-Ride

Abstract: The report summarizes an attempt to demonstrate the feasibility of providing mass transit service for a relatively small urban community (approx. 66,500 population). The project employed a fleet of small-size (19-passenger capacity) buses operated over routes oriented to passenger demand with fares based upon the intensity of these same demands.

All pertinent routing and scheduling data were collected in two surveys which employed two types of interviewing -- on-bus interviews and neighborhood interviews. Survey methodology and analysis is briefly described. The on-bus interviews provided information on volumes of passengers along each route, socio-economic profiles of passengers, and rider opinions about the project generally. Neighborhood surveys were used to determine a cross-section of socio-economic data and travel habits involving the entire urban area.

A number of conclusions were reached which relate directly to the small size of the urban area in which the demonstration was undertaken. Fare variations were tested by reducing fares 40% during the lowest-volume hours. This resulted in a marked redistribution of ridership, although overall passenger volume was not affected. Additional feasibility testing revealed that, because of New Castle's relatively small size and lack of downtown traffic congestion, neither park-and-ride facilities nor express feeder lines were advantageous. In neither case did the experiments result in increased ridership.

NTIS Order #: PB-185-218
PC \$6.00, MF 95¢

Title: "Advertising and Promotion Demonstration Program: Final Report"

Author: Port Authority of Allegheny County, Penna.

Date: UNDATED

Proj. #: PA-MTD-7

Keywords: 1. Advertising and Promotion 5. Ridership, attraction
2. Computer, applications 6. Information Aids
3. Demography 7. Trip Generation
4. Public Relations 8. Market Research

Abstract: The report covers a demonstration project designed to develop concepts and techniques for information, advertising, and promotion, and to test their effectiveness for increasing ridership in an existing transit system. The Philadelphia area was determined to be a particularly relevant testing ground because of an existing system which controls virtually all of the public transit throughout the metropolitan region.

The project initially employed market research methods and demographic analysis to pinpoint economic, racial, ethnic and age groups within the community and to determine the basis for existing ridership patterns among them. The findings were employed also to determine what messages or promotional techniques could be most effective in changing the recognized attitudes and habits. Research methodology is outlined in detail along with the findings.

The program focused particularly upon off-peak ridership in an effort to divert some peak-hour volume through advertising and other promotional means. The report stresses the importance of market research and demographic analysis as undertaken initially in formulating effective promotional campaigns.

Five specific conclusions were reached: (1) Off-peak ridership could be increased as a direct result of improved transit information and distribution of a transit route map. (2) Transit ridership could be effectively simulated by computer as a function of such variables as weather, time of day, seasonality, etc. (3) Telephone information service for transit users was patronized more frequently by present users than by potential passengers. (4) Advertising of transit service generally did not prove conclusively to increase overall ridership. (5) Unanticipated variables such as civil disorders, an exact fare requirement, local political events, and a transit work stoppage resulted in clearly negative influences on ridership.

The report includes reproductions of ads, scripts, brochures, maps and a 45 r.p.m. phonograph record for use on radio spots.

NTIS Order #: PB-194-500
PC \$3.00, MF 95¢

Title: "Minicar Transit System (Final Report)"

Author: Vukan R. Vuchic (ed.), et. al. (Univ. of Pa. Center for Research & Experiment)

Date: 1970

Project No. PA-MTD-8

Keywords: 1. Private Transportation, automobiles 5. Computer, applications
2. Parking, planning 6. Time Costs
3. Quantitative Analysis 7. Air Pollution
4. Qualitative Analysis 8. Financing Mass Transportation, re-
quirements

Abstract: The Minicar Transit System (MTS) consists of a set of terminals, located at many points throughout an urban service area, and a fleet of specially designed small-car vehicles. Any person who satisfies certain requirements with respect to driving capability, insurability, and credit can become an MTS user. The user has a credit card with an identification number which allows him to rent a Minicar at any one of the terminals for a single trip, or for an extended period of time, after which he can drop the Minicar off at that or any other terminal. In addition to the monthly-billed credit system, provisions for cash transactions can be incorporated into the System to extend service for users as tourist travel, airport access, etc.

The times and locations of the checking out and checking in of vehicles are recorded and transferred, via an information system, to a central facility. Additional data, collected automatically during check-in and check-out procedures, will be used to program maintenance work and to indicate the need for redistribution of vehicles among the terminals to meet demand. Charges for the use of the Minicar are computed on the basis of time and vehicle mileage between two check points. The user does not worry about the fueling or maintenance of the vehicle; the insurance is included in the charges.

Most Minicar operations will take place in urban areas. Consequently, the MTS will serve mostly relatively short trips; requirements for minimum parking space and reduction in exhaust pollution are of particular importance. Since the vehicles will be rented, they must be easily adaptable for use by different drivers. In order to achieve optimum economy, the author states that vehicle maintenance procedures need extensive standardization; the author feels that these operating characteristics, not being peculiar to any previously designed vehicle, should be provided for in a special minicar design.

The study has found that the MTS is technologically feasible. A number of refinements of components developed for the vehicle, in the terminals, and for the information system, the author says, should be studied further; none of them, he adds, is critical for technological feasibility of the system. The most important result of the study, with respect to system technology, is development of a prototype vehicle which incorporates a number of new solutions and conceptually satisfies all the basic requirements of specialized service. It has a length approximately half that of conventional vehicles, a very low wheel-base/tread ratio, and a hybrid power train with low levels of pollutant emissions. With some additional development work, the author feels that the vehicle will meet basic requirements and be much more efficient in urban conditions than conventional automobiles.

NTIS Order #: PB-196-370
PC \$3.00, MF 95¢

Index No. 1-PA-8.1

Title: "Minicar Mass Transit System - Final Report on Phase I: Feasibility Study - Book I, Summary"

Author: University of Pennsylvania

Date: December, 1968

Proj. #: PA-MTD-8

Keywords: 1. Private Transportation, automobiles
2. Traffic, congestion
3. Traffic, flow
4. Suburbs

Abstract: The purpose of this study is to evaluate the feasibility of the minicar for implementation as a mass transit system for intracity and commuter movement. The Minicar Mass Transit System (MMTS) concept: (1) uses a very short car as the basic component, (2) can be implemented without major capital expenditures other than for the vehicles, (3) is as readily available as a taxicab, (4) costs the user less than a privately owned "standard" automobile, and (5) costs the user more than mass transit. Commuters would subscribe to a "Flat Rate" service, and city travelers would subscribe to the system and obtain cars on a "Trip Rate" basis.

Minicar facilities would be distributed throughout the central city area so that any one of them can be reached by walking for no more than about two minutes. The Minicars brought into the city by the commuters are to be used for the "Trip Rate" service, or by fleet users during the working day. The commuter returning home obtains a Minicar, but not the one he dropped off in the morning. The system is to be automated. Check-in and check-out, as well as billing, is to be computer controlled. A dual computer system with high reliability is envisioned.

The authors concluded that the Minicar system could: (1) increase the traffic capacity and flow in heavily congested areas by 25% to 75%, (2) decrease localized rush hour air-pollution levels by 40%-60%, (3) release a potential investment of \$0.4-\$0.7 billion in parking facilities for other important urban uses, and (4) reduce the suburban auto commuter's usage of subway, train, and bus transit systems by providing him with central city transportation convenient to the downtown terminals of these systems.

NTIS Order #: PB-184-147
PC \$6.00, MF 95¢

Title: "Minicar Mass Transit System - Final Report on Phase I: Feasibility Study - Book II, Summary"

Author: University of Pennsylvania

Date: December, 1968

Proj. #: PA-MTD-8

Keywords: 1. Private Transportation, automobile
2. Center City
3. Communications
4. Maintenance, facilities
5. Parking, cost

Abstract: The purpose of this study is to evaluate the feasibility and desirability of introducing reduced-emission, length-limited vehicles, within a rental-fleet context called the Minicar Transit System (MTS), into central parts of metropolitan areas. The test case, upon which these concepts have been based, is designed for the Philadelphia Central Business District.

In its essential aspects, the MTS can be defined as a combination of physical components and operational concepts. It includes the following: (1) a network of terminals which can receive and deliver vehicles; (2) a communications system that permits the rapid transmission of information related to vehicle availability, utilization, accounting, safety and maintenance; (3) a program and facility of maintenance that permits the immediate, accurate, and economical maintenance of the vehicles, the terminals and the communication system; and (4) a type of operation which maximizes the utilization of the MTS, results in a high level of service to the public, and reduces the system's capital and operational cost. This concept is a fleet operation in which many users share the use of the total system.

It is proposed that the MTS use existing garages and parking lots as terminals. The physical dimensions of these facilities were designed for conventional cars (Posts, aisles, and structures are fixed and unchangeable.) to park perpendicular to, and on either side of, an access way. When converting to fleet parking, the gains actually made are very dependent on reducing the size of the individual vehicle to one half or less of original design lengths. Similarly, in parallel parking at curbs with parking meters, the difference between the space required by 18' and 15' cars is about 33 percent and requires moving the meter; however, two nine foot Minicars could be accommodated in one regular space. By parking the Minicar perpendicular to the curb, the parking density may be tripled.

A financial analysis was conducted to assess financial soundness and profitability, capital requirements and sources, growth rates, and initial investment necessary to maximize the probability of success. To obtain this information, two financial statements, a Proforma Balance Sheet and a Proforma Cash Flow Sheet, were prepared. Rather than being a true cash flow statement, the Proforma Cash Flow Sheet is, in effect, an income statement without a depreciation allowance. Through the use of these two statements, the required information was assembled. The following estimates and assumptions were made: (1) The cost of each car to the system will be \$2,500. (2) The cost of each maintenance truck to the system will be \$50,000. (3) The monthly insurance cost is estimated at \$25/car and license/title fees are estimated at \$20/year/car paid in the first quarter of each year. (4) Monthly parking costs of \$9.64 per car are estimated from typical monthly-rate parking in the Philadelphia central business district.

NTIS Order #: PB-188-046
PC \$6.00, MF 95¢

Title: "Acquisition and Public Operation of Transit Services in Providence-Pawtucket Metropolitan Area"

Author: Simpson & Curtin, Transportation Engineers (for Rhode Island Public Transit Authority)

Date: June, 1965

Proj. #: RI-MTD-1

Keywords: 1. Financing Mass Transportation, sources
2. Land Use
3. Public Ownership
4. Government, urban
5. Ridership, volume
6. Trip Generation
7. Schedules and Scheduling
8. Intermodal Competition
9. Bus, priorities
10. Management, operations and analysis
11. Urban Development, planning
12. Demography

Abstract: The report analyzes factors involved in public acquisition and operation of transit services in an urban area, with specific reference to the Providence experience. The authors provide a comprehensive background and analysis of existing operations which reveals a common profile of service deterioration and ridership decline under private transit management. Area demography and land use is examined along with the results of statewide comprehensive transportation planning. Trip characteristics, peak-hour demand, and a ridership profile are also outlined. Finally, the background material includes a discussion of near-term factors affecting transit such as relevant state court decisions and creation of a Rhode Island Transit Authority.

All aspects of the existing system are examined, including fares, running time, scheduling, competition from other modes, and responsiveness to trip generation. Transit improvements over the next decade are projected in terms of overall urban planning for the area. Such innovations as express bus operation, bus priorities on expressways, park-and-ride, and link-up with proposed conveyor distribution systems for the Central Business District are discussed.

The case for public ownership is thoroughly analyzed from all relevant aspects. Particularly, the authors discuss alternative forms of operating control available to the public transit authority, and satisfaction of public interest in each. Staff management, professional management, and leaseback to private management are examined. The implications of public ownership are also discussed in two fundamental respects: (1) economies generated, and (2) obligations incurred. Among the economies emphasized are tax savings and personnel reductions. Liabilities incurred include tort claims, pension payments, and equipment maintenance and replacement.

The results of past operations are outlined and projected under public ownership. The authors particularly emphasize prospective earnings and ridership as calculated by the Transit Authority, the private management, and by investment bankers. The availability of Federal assistance under public ownership is discussed. Finally, a complete inventory of capital equipment and facilities and their valuation in the existing (private) system is documented.

In a final section, the authors summarize their analysis and consider two alternative means of public acquisition: (1) negotiated purchase, and (2) condemnation. Progress in negotiations between the Transit Authority and the private company is outlined, with the authors' conclusion that the negotiated purchase price should be accepted.

NTIS Order #: PB-174-417
PC \$6.00, MF 95¢

Title: "Arriving Late in Suburbia: The Buttonwoods-Providence Express and Local Shoppers' Shuttle (Final Report)"

Author: Rhode Island Public Transit Authority

Date: November 6, 1967-October 31, 1968

Project No. RI-MTD-2

Keywords: 1. Bus, commuter
2. Bus, express
3. Suburbs
4. Market Research
5. Advertising and Promotion
6. Trip Generation
7. Ridership, attraction

Abstract: The report describes a demonstration project designed to test the potential demand for urban mass transportation in an automobile-oriented suburban area. The project also sought to learn how modern marketing and public relations techniques could identify transit needs and induce suburbanites to abandon automobiles in favor of the public mode.

The demonstration was conducted along a well-populated corridor in Warwick, Rhode Island, a suburban area near Providence. The 8,900 persons who resided within one quarter mile of the project route were considered characteristic of suburbanites who depended principally upon private transportation for all trips. The project instituted two special express bus services: (1) four daily commuter trips to and from the Providence center city; and (2) regularly scheduled off-peak shuttle service to nearby shopping centers. A comprehensive market research program was employed to identify potential ridership within the corridor, and a massive publicity and advertising campaign was undertaken to induce patronage.

The commuter routes were sufficiently well-patronized to justify retention of three morning and afternoon trips between Warwick and downtown Providence. Relocation of a Bulova Watch Company factory to Warwick was found to generate substantial demand for express service to and from the plant. The shoppers' express, however, sustained major financial losses and was abandoned upon completion of the demonstration project.

The authors advance four major conclusions: (1) Only a small percentage of residents in a suburban area that has long been without mass transit will be attracted to new service. (2) To assure successful operation of mass transit for a suburban area, residents of the area must include a large number of workers commuting to jobs near the new route. (3) There is little chance of success for shoppers' service in a suburban area long without mass transit. (4) The full range of marketing and public relations techniques must be applied not only to introduce new service but to sustain it.

The report documents fully all aspects of the demonstration, including background information, a description of the project area, service development procedures, scheduling and fare structure, promotional techniques, ridership and revenue data, and results of the market research studies. All relevant statistical material is appended.

NTIS Order #: PB-190-868
PC \$6.00, MF 95¢

Index No. 1-RI-2.1

Title: "Mass Transportation Studies in Memphis - Transit Systems' History 1956-1965"

Author: Memphis Transit Authority

Date: March, 1965

Proj. #: TENN-MTD-1

Keywords: 1. Ridership 3. Routes and Routing
2. Public Ownership 4. Bus, express

Abstract: This study is divided into two sections. The first report details the activities of the Memphis transit system from 1956 to 1961 when it was privately owned, and from 1961 to the present when it has been publicly owned. The basis of the report was comprised of information obtained from the records of the City of Memphis, its committees and consultants, the records of the transit company, and newspaper files. The second report outlines what happened to transit ridership as a result of a demonstration project that provided full-scale bus service in each of three different types of rapidly growing Memphis suburban areas.

The Memphis Transit Company, a private corporation, had been providing transportation service in Memphis since 1896. Its service had remained at about 9,500,000 miles a year since 1958 and had not kept up with the residential growth in the fringes of the city. Revenue passengers had declined as automobile registrations increased. In 1960, the fleet of the company consisted of 266 buses. Of these, 166 were more than 10 years old, 60 were 10 to 11 years old, and the 40 newest were 4 to 6 years old. In 1956, the Memphis Transit Plan was drawn up by W. W. Dibble Company, a consulting firm. In addition to the relocation of some lines, the report recommended: (1) elimination of duplicated bus service, (2) creation of additional crosstown lines at approximately two-mile intervals, and (3) use of express-local service on major lines operating in the eastern half of the city. The Memphis City Commission recommended adoption of the "Memphis Transit Plan--1956" and the purchase of a substantial number of new 51-passenger diesel buses. The committee also recommended that if the existing 6 per cent of gross receipts payable to the City was eliminated, a fare structure that would produce an average fare of 18 cents per passenger would be permitted. Because of decreasing revenues and declining ridership, the Memphis Transit Company sold its entire properties to the City for \$2,333,546.

A demonstration project began on March 10, 1963, with its objective being to determine the effects (upon transit ridership) of establishing full-scale mass transit service in the early stages of the development of various types of suburban areas, in comparison with the effects observed when such service is deferred until the major part of the development has taken place. Three project areas were selected: the Oakville-Parkway Village, Chickasaw, and Raleigh-Bartlett regions. The authors concluded from the study that when full scale transit bus service is put into effect in the early stages of growth in a suburban area, it will become truly effective in about four to six weeks. That appears to be the time that is needed for the residents and those who enter the area to become aware of the existence and potentialities of the bus service. After such a beginning period, the riding habits of the bus users will steadily increase to the extent that the ratio of bus passengers to population will become 10% to 30% higher within a period of one to one and one-half years. The greatest increases will be in the areas of low cost housing, where most of the bus riders will be residents of the area, and in the areas of medium to higher priced housing, where most of the bus riders will be domestics and others who are not residents of the area.

NTIS Order #: PB-174-418
PC \$6.00, MF 95¢

Title: "Experimental Bus Lines In Metropolitan Nashville"
Author: Metropolitan Planning Commission, Nashville, Tennessee
Date: Fall, 1966 Proj. #: TENN-MTD-2 & 3

Keywords: 1. Bus, Express 5. Survey
2. Bus, Cost 6. Land Use
3. Financing Mass Transportation 7. Private Transportation, Automobiles
4. Demography 8. Benefit-Cost Analysis

Abstract: The basic goal of this demonstration project was to study the attitudes of patrons toward certain unique experimental bus lines operated within the urban area, and to develop a basis for predicting probable results of similar lines by relating certain observed land use, social and economic characteristics of the areas served. An additional study purpose was to demonstrate a more complete integration of transit services and to reveal how the experimental lines either complemented or detracted from the overall network of transit lines.

Two types of interview surveys were utilized in identifying the characteristics of those riders served by the experimental bus lines. The Household Survey established the prevailing socio-economic characteristics of households and travel habits and the On-Bus Survey developed socio-economic characteristics of riders, the origin and destination of riders and other trip information.

This project included study of the Woodmont-Thompson Line, University Center Line, Donelson Local Service, and the Hermitage Hills Extension. The Donelson Express Service was studied under TENN-MTD-3. For each of these experimental lines the characteristics of the service and of ridership and the type of transit service were analyzed.

It is possible that as long as cost and revenues are the sole measures of transit service feasibility, the application of public transit to the urban transportation problem will be limited. The author states it may be in the public interest to encourage transit ridership with public subsidies to reduce the volume of vehicular traffic at certain locations and times. If this is the case, then cost and revenue may not be a suitable measure of feasibility. In appraising the relative success of the various demonstration lines, it is apparent that a single line cannot be operated in isolation from the overall system, but that it must be compatible with the system in terms of function, scheduling, and transferring. Each of the relatively successful lines were functionally linked with the larger transit system.

Not only did this study demonstrate the importance of the interrelationship of transit service, but the utility of interrelated local and express routes in the overall system was revealed. Local lines were able to penetrate low density areas, and the express line provided rapid service to the Central Business District. As long as the central area is the core of trip generation and radial routes leading into the central area can accommodate express lines, then this approach seems very feasible. The influences upon the level of transit ridership are diverse and vary among transit lines. While the characteristics of the area served in terms of income, number of household automobiles, and development density were important variables influencing the level of ridership, they may be somewhat overrated as to their pervasiveness.

NTIS Order #: PB-174-758
PC \$6.00, MF 95¢

Title: "Hospital and Medical Center Express Bus Service Project - Final Report"

Author: Metropolitan Transit Authority, Nashville, Tennessee

Date: December, 1970

Proj. #: TENN-MTD-4

Keywords:

1. Bus, express	6. Routes & Routing
2. Medical Centers	7. Schedules and Scheduling
3. Center City	8. Trip Generation
4. Surveys	9. Private Transportation
5. Ridership, profiles	10. Employment
	11. Financing Mass Transportation

Abstract: The purpose of this project was to establish direct express bus service between the varied, and in some cases widely separated medical centers of Metropolitan Nashville-Davidson County, and at the same time furnish frequent service from these medical centers to the central business district of Nashville.

Prior to commencement of the new service, surveys were made of medical center employees and patients in an effort to determine their origin as related to their destination at each medical center. These surveys were used in establishing the route of the Express Bus Service.

After the service was established, an on-bus survey was undertaken to provide information on the socio-economic characteristics of the people who were actually using the experimental service and to develop specific traffic information on tripmaking and previous modes of travel. In the second year of the demonstration project, a follow-up on-bus survey was conducted for comparative purposes in order to determine possible future innovations for further development of hospital express service.

A study program to achieve a systematic approach to project objectives was designated. Steps were planned to achieve, in a period of eight quarters of operation for 2 years, ridership information and other data.

Nashville medical centers and hospital administrators were aware of the importance of public transportation and cooperated during the demonstration in an effort to encourage their employees, outpatients, and visitors to use public transit.

Employees, outpatients, and visitors to medical centers who have automobiles available will generally drive if parking space is available at a reasonable cost. The project did demonstrate that a small number of automobile commuters were induced to switch to public transportation when the service provided was convenient and reliable.

Medical centers which in some instances are forced to locate in areas where public transit is not available find it difficult to employ people. The report concludes that establishment of direct public transportation service to the centers eases the burden of recruiting the hospital employees and minimizes the employee turnover rate. The report also recommends that medical centers that are not on established bus routes or are within a short distance of an established route should work with their local transit system to obtain better service, and, if it becomes necessary, cooperate with local governmental agencies in establishing a subsidy program.

NTIS Order #: PB-197-800
PC \$3.00, MF 95¢

Title: "A Study of Internal Circulation Systems for the Post Oak Urban Center, Houston, Texas"

Author: Urban Design and Development Corporation

Date: March, 1970

Project #: TEX-MTD-4

Keywords: 1. People Movers
2. Center City
3. Private Transportation
4. Vehicle, design
5. Personal Rapid Transit
6. Suburbs, business district
7. Financing Mass Transportation
8. Fares, cost determination

Abstract: This paper refers to three types of internal circulation systems proposed for use in the Post Oak Urban Center: (a) the horizontallator, (b) the mini-transit system, and (c) the personal rapid transit system (PRT).

The distinction between the horizontallator and the mini-transit system is derived from institutional considerations. The horizontallator is a private system, installed by the center developer and paid for out of incremental rental charges for space within the project, which the public can use without charge. The mini-transit system is simply a version of public utility transportation scaled down in capacity and proportionately in price, paid for largely out of the fare box with the possibility of tax subsidies and competing with the automobile and bus for ridership.

The distinction between mini-transit and personal rapid transit systems is related to the type of service. Both operate at peak capacity during rush-hour, but mini-transit provides primarily trunk line access, with core distribution functions in high density areas; PRT includes both collection and distribution. The greatest benefits of PRT would accrue during the non-peak hours when the system would replace the private automobile and taxi for shoppers and businessmen.

The distinction between the horizontallators and PRT systems is basically a technical one. Within the institutional framework of horizontallators, it would be possible to install a system which would permit door-to-door service; however, the costs could escalate enough to force accounting of the use of the system and allocation of charges in proportion to benefit. This would be incompatible with the concept of horizontallators as a building service freely available, such as elevators and air-conditioning.

The mini-transit system is essentially a public system for which the riders pay directly; the economics of mini-transit are expressed in the cost per passenger trip of operating the system. PRT is also primarily a public system and must compete with taxi fares on the basis of cost per passenger mile. In each case, the system is competing against the current investment in motor cars, streets, and highways, and either's adoption is sensitive to the faith in modal split models predicting patronage and demand. By contrast, the horizontallator does not compete for transportation patronage; its economic objective is to increase the volume of business done at the specific location so that the added cost of the system becomes a profitable investment of the commercial enterprises.

The author, engaged in demonstrating that the private sector can provide circulation systems in both downtown and suburban major activity centers, aims to identify in this report the system class, the basic economics, and the operational characteristics and performance requirements on which industry can concentrate its efforts to develop an efficient and appropriate system for such use.

NTIS Order #: PB-198-614
PC \$3.00, MF 95¢

Title: "Chesapeake Mass Transportation Demonstration Project"

Author: Wilbur Smith and Associates

Date: January, 1969

Proj. #: VA-MTD-1

Keywords:	1. Bus, express	5. Headways
	2. Bus, feeder	6. Fares
	3. Routes and Routing	7. Surveys
	4. Schedules and Scheduling	8. Trip Generation
		9. Demography

Abstract: The City of Chesapeake, Virginia, sponsored and administered a 2-year study to test whether new residents of a suburban community would use a public transportation facility for work trips to the central city if frequent, low cost, express bus service was made available. The demonstration also tested the possible increased opportunities and effects that the availability of the bus service would have on other activities of the residents. These related to opportunities for work, encouragement of new residential growth, and stimuli to commercial development.

On December 14, 1966, an addition to the demonstration project service was made in furtherance of its original scope and purpose. This provided for feeder bus service to four residential areas beyond the service area of the main line to Norfolk.

The objective of the feeder bus route was to determine if the residents of these small or outlying communities would be attracted to the express bus service if there was bus feeder service to bring them to a connecting point on the express bus route. It was also desired to ascertain the characteristics of riders attracted to the feeder bus primarily for the access it provided to the express bus, and of those using it for local travel between Great Bridge and the outlying communities. Another important aspect was whether the improved connection with express service to a large city core has an impact on the employment status and social opportunities of the population in the fringe communities.

The service provided by the demonstration line was full-scale express service making 27 trips per day, and operating on a 35-minute headway throughout the day. The week-day bus trips began in Norfolk at 5:10 A.M. and the last trip departed Norfolk at 8:55 P.M. daily. The new Sunday and holiday schedule provided service for the area residents for church attendance and recreation, as well as accommodating service personnel and Sunday workers. Minor rerouting of the line reached several housing areas not previously served.

The monthly trends, hourly variation in bus riding, miles operated and passenger volume are summarized.

On-board bus surveys included complete interviews with individual bus passengers on all inbound trips and were performed periodically during each quarter of the 2-year demonstration period. The bus rider interviews provided a base for review of the impact on transit riding habits in the communities served by the line. The survey results are listed according to age, sex and occupation of the bus rider and were correlated with the city growth factors, and the operational characteristics of the express bus line.

The conclusions reached as the results of the demonstration are summarized in the report. The appended material includes: (1) a copy of on-board bus interview forms, (2) Home Interview, (3) Norfolk-Great Bridge Express Bus Service, and (4) Express Bus Schedule.

NTIS Order #: PB-185-657

PC \$6.00, MF 95¢

Index No. 1-VA-1.1

123

Title: "The Urban Mass Transit Game (Maintenance) -- Technical Report
Phase IA: Instructions for Participants"

"The Urban Mass Transit Game (Maintenance) -- Technical Report
Phase IB: Administrative Manual"

Author: Virginia Polytechnic Institute, Department of Industrial Engineering

Date: Undated

Proj. #: VA-MFD-2

Keywords:	1. Games and Game Theory	5. Management, Planning and Analysis
	2. Computer, Applications	6. Management, Training Techniques
	3. Computer, Programming	7. Manpower and Personnel
	4. Maintenance	8. Management, Operations and Techniques

Abstract: The Urban Mass Transit Game (Maintenance) is a computer-based simulation exercise or management game that is focused upon the maintenance function of a municipal bus company. The game participant is required to manage this department -- to direct a work force towards the completion of a daily schedule of work requirements. A unique feature of the game is the inclusion of distinct people -- a work force of mechanics that assume separate and diverse identities.

The Phase IA report includes a brief introduction, first to gaming and game theory generally, and then to their application in the mass transit industry. The main body of the report consists of specific instructions to game participants as well as some auxiliary case problems.

The Phase IB report outlines more specific instructions for game leaders and for programming the computer. Additional program documentation as well as the specific Fortran computer program are included. The report concludes with results of a pilot test conducted with the New York City Transit Authority.

The purpose of the Urban Mass Transit Game (Maintenance) is to provide simulated management experience in a difficult and complex aspect of transit operations. The game may be particularly useful in projecting the effect of theoretical maintenance requirements and methods onto existing mass transit systems.

In operation, the game requires a 25-day simulation period and a computer system with Fortran IV Compiler capability. The authors note also the flexibility with which the game parameters can be adapted to local conditions.

NTIS Order #: [1-A] PB-194-686
" " " [1-B] PB-194-687
Each Volume: PC \$3.00, MF 95¢

Index No. 1-VA-2.1

Index No. 1-VA-2.2

Title: "Seattle Monorail Demonstration Study"

Author: D.E. Alexander (University of Washington)

Date: Oct., 1962

Proj. #: WASH-MTD-1

Keywords: 1. Surveys
2. People Movers, Monorail
3. Maintenance, costs
4. Noise and Noise Control
5. Vibration
6. Financing Mass Transportation, re-
quirements

7. Safety
8. Public Relations
9. Switches and switching
10. Joints and Joining
11. Land Use
12. Right-of-Way

Abstract: This report presents the findings of a study of the operation of 1.2 miles of monorail in connection with the Seattle World's Fair, under agreement between the Federal Housing and Home Finance Agency and the University of Washington. The purpose of the study is to present a comprehensive appraisal of the effectiveness of the monorail as a metropolitan rapid transit facility by collecting and analyzing factual data from 6 months of operation during the Seattle World's Fair -- April 21, 1962, through October 21, 1962. Collection and analysis of data pertaining to the operation of the Seattle monorail installation is made with a view to obtaining information that will be useful to the formulation of decisions on the use of a monorail system in Seattle and other metropolitan areas of the United States.

Mechanical and structural characteristics were determined through observation, consultation, and measurement. Appropriate instrumentation was used where necessary. Construction and operating costs, including maintenance and depreciation, were obtained from Alweg engineers and accountants. Assumptions underlying cost allocations were examined. Public acceptance of monorail as a mode of rapid transit was investigated by means of statistical sampling procedures involving interviews and questionnaires.

The report includes: the analysis of capital and operating costs pertinent to a determination of financial feasibility of the system under various conditions of commuter demand; operating characteristics (such as noise, vibration, speeds, smoothness, load time and comfort) and the mechanical problems attending the operation of the trains and terminals; structural characteristics (such as footing, settlements or tilting, beam camber, switching, joints, strength and safety); right-of-way problems and effects on street capacity and traffic; public acceptance among riders, adjacent property owners, adjacent business proprietors and the general public; effects of the system on adjoining business and property values; and the coordination of the system with parking facilities and with other transit facilities.

NTIS Order #: PB-174-423
PC \$6.00, MF 95¢

Index No. 1-WASH-1.1

Title: "Blue Streak Bus Rapid Transit Demonstration Project -- Phase I: Interim Report"

Author: Alan M. Voorhees & Associates, Inc. (for Washington State Highway Commission and City of Seattle)

Date: 1971 Proj. #: WASH-MTD-2

Keywords: 1. Bus, express 5. Modal Split
2. Bus, commuter 6. Surveys
3. Bus, priorities 7. Traffic, peak-hour
4. Ridership, attraction 8. Parking, Park-and-Ride

Abstract: The report documents results of Phase I of the Blue Streak Demonstration Project. The purpose of this project was to develop an express bus service between the Seattle central business district and special park-and-ride facilities on the urban periphery. The authors note that a principal focus of Phase I operations was to create an attractive alternative to automobile commutation on the City's congested freeway network. Consequently, buses were given exclusive use of certain high-demand freeway ramps and reversible peak-hour lanes on the major urban highway artery.

Phase I consisted of project planning and implementation; therefore, ridership data contained in the report is inconclusive. The purpose of the report is to outline initial survey data and provide a project overview for later comparisons with long-range ridership information. The Blue Streak planning process and the roles played by different participants are discussed briefly.

Phase I analysis contains data on ridership, modal split, and traffic volume by time of day after commencement of express bus service. Survey procedures are discussed in detail; basically, the authors collected data at two "screenline" points along the route. These were: (1) terminal bus stops in the central business district, and (2) bridge crossings over the Lake Washington Ship Canal which ran perpendicular to Blue Streak routes. In addition, the report covers average speeds along different segments of the freeway network, traffic volume on selected downtown access ramps, travel time from selected trip generators, an origin-destination survey, and overall ridership broken down by such indicators as family income, automobile accessibility, and bus-access mode. Headways among buses operating on selected routes were also determined.

Although the data generated by Phase I were collected primarily for comparative purposes at a later date, some initial conclusions were advanced. The authors note that inter-agency cooperation among the various transportation departments serving Seattle was instrumental in making Blue Streak a successful venture. Early results clearly indicated a significant diversion of previous automobile commuters to the express bus, primarily due to the availability of park-and-ride facilities. Preliminary estimates indicated that as much as 30% of overall ridership was newly generated.

NTIS Order #: PB-206-629
PC \$3.00, MF 95¢

Title: "Blue Streak Bus Rapid Transit Demonstration Project -- Phase I: Interim Report"

Author: Alan M. Voorhees & Associates, Inc. (for Washington State Highway Commission and City of Seattle)

Date: 1971 Proj. #: WASH-MTD-2

Keywords: 1. Bus, express 5. Modal Split
2. Bus, commuter 6. Surveys
3. Bus, priorities 7. Traffic, peak-hour
4. Ridership, attraction 8. Parking, Park-and-Ride

Abstract: The report documents results of Phase I of the Blue Streak Demonstration Project. The purpose of this project was to develop an express bus service between the Seattle central business district and special park-and-ride facilities on the urban periphery. The authors note that a principal focus of Phase I operations was to create an attractive alternative to automobile commutation on the City's congested freeway network. Consequently, buses were given exclusive use of certain high-demand freeway ramps and reversible peak-hour lanes on the major urban highway artery.

Phase I consisted of project planning and implementation; therefore, ridership data contained in the report is inconclusive. The purpose of the report is to outline initial survey data and provide a project overview for later comparisons with long-range ridership information. The Blue Streak planning process and the roles played by different participants are discussed briefly.

Phase I analysis contains data on ridership, modal split, and traffic volume by time of day after commencement of express bus service. Survey procedures are discussed in detail; basically, the authors collected data at two "screenline" points along the route. These were: (1) terminal bus stops in the central business district, and (2) bridge crossings over the Lake Washington Ship Canal which ran perpendicular to Blue Streak routes. In addition, the report covers average speeds along different segments of the freeway network, traffic volume on selected downtown access ramps, travel time from selected trip generators, an origin-destination survey, and overall ridership broken down by such indicators as family income, automobile accessibility, and bus-access mode. Headways among buses operating on selected routes were also determined.

Although the data generated by Phase I were collected primarily for comparative purposes at a later date, some initial conclusions were advanced. The authors note that inter-agency cooperation among the various transportation departments serving Seattle was instrumental in making Blue Streak a successful venture. Early results clearly indicated a significant diversion of previous automobile commuters to the express bus, primarily due to the availability of park-and-ride facilities. Preliminary estimates indicated that as much as 30% of overall ridership was newly generated.

Title: "The Development and Demonstration of an Automatic Passenger Counter --
Volume I"

"The Development and Demonstration of an Automatic Passenger Counter --
Volume II"

Author: Sammy E. G. Elias and Nelson S. Smith (West Virginia University)

Date: June, 1970

Proj. #: WVA-MTD-2

Keywords: 1. Passenger Counters 5. Sensors
 2. Computer, Applications 6. Schedules and Scheduling
 3. Computer, Programming 7. Headways
 4. Routes and Routing 8. Instrumentation

Abstract: The reports summarize a project to: (A) design and construct an automatic passenger counter that would count the number of passengers entering and leaving a bus at selected stops, relate these counts with the bus stop location, record both counts and location data on a tape which could be used as an input to a computer; and (B) develop a set of computer programs which would convert these data into bus schedules showing optimum vehicle numbers and headway required under specific assumptions of load and capacity.

The counting employed a sensing unit located in the doorway of the bus which consisted of two photo-electric sets. Passengers entering and leaving the bus interrupted these beams in sequence, activating a recording unit housed beneath the bus seats. Power supply, design, and other data relating to manufacture of the sensors is detailed.

To identify the location of specific passenger counts recorded, transmitters were mounted along the bus route at critical stops. Signals from these transmitters activated a printer in the recording unit to note the appropriate symbol for each stop next to the passenger count. A digital clock, activated by each interruption of the photo-electric "eyes", similarly signaled the printer to record the time at each location. Thus three pieces of information were simultaneously recorded by the method described in this report: time, location, and number of passengers.

Output from the counter was in the form of a tape which could be used as an input to a computer. The computer then translated passenger-count information into bus schedules showing vehicle numbers and required headway for optimum service vis-a-vis demand. Volume II includes detailed instructions for programming the computer as well as schematic diagrams for constructing the counter. The authors note that subsequent testing revealed their mechanical counters to have been 95% accurate versus manual counting and that subsequent computerized scheduling based on their data proved more efficient than ones manually developed.

NTIS Order #: [Vol. I] PB-193-905
 " " " [Vol. 2] PB-193-906
Each Volume: PC \$3.00, MF 95¢

Index No. 1-WVA-2.1

Index No. 1-WVA-2.2

Title: "A Feasibility Study of an Integrated City and University Transportation System (Final Report)"

Author: Samy E. G. Elias (West Virginia University)

Date: August, 1970

Proj. #: WVA-MTD-3

Keywords: 1. Rail, Commuter
2. Distribution Systems
3. Electronic Vehicle Guidance
4. Headways
5. People Mover, Varo Monocab
6. People Mover, Dashaveyor
7. People Mover, Alden StaRRcar
8. Guideways
9. Center City

Abstract: The report summarizes activities and findings of the first three phases of a five-phase design cycle for the West Virginia University-Morgantown Mass Transit Program. The goal of the project was to determine the feasibility of demonstrating a new mass transportation technology in the adjacent areas of metropolitan Morgantown and the University campus. The phases reported on embrace the following: (1) concept validation, (2) system sorting, and (3) preliminary design and system definition.

In terms of concept validation, the report describes methodology and problem definition in detail. The Morgantown site was found to provide a variety of transit requirements including: (1) relatively long-haul commutation between residential areas and the central business district; (2) relatively short-haul commutation by students among the University's three city campuses; and (3) distribution capabilities in the downtown section.

Specific criteria are detailed for system sorting and the synthesis of design specifications. These are tailored to the system requirements determined earlier, and reflect economic factors as well as performance capabilities. Selection of a headway-variable, fixed guideway, automated system was recommended. These criteria were screened against several system alternatives.

Results of the screening yielded three candidates: the Varo Monocab, the Dashveyor, and the Alden StaRRcar. Each system developer was awarded a contract to conduct preliminary engineering design studies in the Morgantown area. Results of these studies evidenced the adaptability of all three systems to meet selected service demands, but the Alden StaRRcar was rated as the system which could respond best to the problem in Morgantown in terms of: (1) level of service, (2) system flexibility, and (3) future potential.

Recommendations for follow-up stages, including final design, installation, and demonstration of the StaRRcar are advanced.

NTIS Order #: PB-193-721
PC \$3.00, MF 95¢

Title: "Milwaukee County Dual-Mode Systems Study -- Volume I: Summary Report"

Author: Allis-Chalmers Corporation

Date: December, 1971

Project No. WISC-MTD-2

Keywords: 1. Dual-Mode Systems 3. Bus, rapid transit
 2. Guideways 4. Vehicle, design

Abstract: The report is a comprehensive summary of a project to determine the feasibility and desirability of providing a dual-mode transportation system in the Milwaukee metropolitan area. The dual-mode concept employs transit vehicles capable of both fully-automated operation on a guideway and manual operation on city streets. The report focuses particularly upon dual-mode applications using small bus vehicles which indicate the greatest potential for near-term demonstration.

A socio-economic impact study was undertaken to evaluate the desirability of dual-mode transportation in the Milwaukee metropolitan area. The authors attempted to determine the extent to which a proposed system would satisfy demands projected for the year 1990. The analysis revealed that flexible dual-mode transportation would yield significant advantages with reference to service quality, labor productivity, operation costs, attainment of regional development objectives, demand responsiveness, and growth potential. The authors note, however, that important considerations regarding ridership attraction and other variables cannot be resolved without a comprehensive demonstration of the concept.

The report also summarizes results of a technology survey which yielded two alternative system design concepts. These were subjected to further evaluation to determine overall feasibility. Three basic conclusions were that: (1) Technology will not be an obstacle to system development; no significant breakthroughs are necessary. (2) The critical technical decision appears to be the selection of a steering control concept from among the many available alternatives. (3) The key technical issue will be the attainment of appropriate system reliability levels. The system approach selected for further development and demonstration consists of a 19-passenger, rubber-tired transit vehicle, electrically powered by a hybrid propulsion system and operating under a centralized, scheduled, synchronous longitudinal control concept.

The authors recommend a specific program for development and demonstration of the dual-mode concept as an initial phase of implementation in the Milwaukee County area. The proposed demonstration would span approximately five years and involve 200-300 dual-mode transit vehicles and 15-25 miles of automated guideway. Total cost of the 10-year implementation program will be approximately \$174 million.

The report concludes that dual-mode transportation will offer significant advantages to cities of medium-to-high density and that additional research and development should be encouraged. Federal funding of the proposed demonstration program is recommended.

NTIS Order #: PB-209-242
PC \$3.00, MF 95¢

Title: "Milwaukee County Dual-Mode Systems Study -- Volume II: Technical Evaluation"

Author: Allis-Chalmers Corporation

Date: December, 1971

Project No. WISC-MTD-2

Keywords: 1. Dual-Mode Systems
2. Propulsion Systems, hybrid
3. Guideways
4. Guides and Guidance
5. Power Distribution

Abstract: The report is a comprehensive technical evaluation of the dual-mode transportation concept for application in the Milwaukee metropolitan area. The concept involves bus transit vehicles capable of both fully-automated operation on a guideway and manual operation on city streets. The report sought to identify two system design alternatives for comparison and evaluation.

A technology survey was conducted to explore existing dual-mode designs and previous research in the field. Related transportation studies are reviewed along with detailed summaries of four specific dual-mode concepts, including: (1) Urbmobile, (2) StaRRcar, (3) Commucar, and (4) Palleted Automated Transportation. The authors conclude that none of the existing dual-mode designs is sufficiently developed for near-term implementation. Several evaluative criteria were developed with which to compare two basic alternative systems. Three critical parameters for the analysis were vehicle propulsion, vehicle management at merges, and lateral control. System A employed a hybrid power plant, centralized vehicle management, and electrical follower controls. System B employed a dual AC motor and internal combustion engine, localized vehicle management, and a center wheel mechanical follower control system.

System requirements are outlined with reference to various performance goals. Operational provisions and system functions are also discussed in detail. All basic elements of a dual-mode system are examined, including the vehicle, guideway, and support facilities (such as control and communications subsystems, power distribution, vehicle storage and retrieval, and maintenance facilities).

Both alternative system concepts are also examined with reference to capital and operating costs. The authors note that System A offers obvious economical advantages.

Tradeoffs in hardware design are described at length. Such factors as guideway capacity vs. headways, vehicle performance vs. power requirements, system reliability vs. maintenance costs, and electrification vs. non-electrification are noted. The report also contains a cost sensitivity analysis which reveals the extent to which costs will fluctuate with changes in vehicle speed, loading, and automation.

The report concludes with specific recommendations for system control, propulsion, steering, guideway capacity, and system reliability. The evaluation revealed that System A was superior, and the authors recommend additional development and demonstration of this concept prior to implementation. Fifteen appendices contain relevant statistical material and detailed analytical data.

NTIS Order #: PB-209-243
PC \$6.00, MF 95¢

Title: "Milwaukee County Dual-Mode Systems Study -- Volume III: Socio-Economic Evaluation"

Author: Allis-Chalmers Corporation

Date: December, 1971

Project No. WISC-MTD-2

Keywords: 1. Dual-Mode Systems 5. Bus, cost
 2. Benefit-Cost Analysis 6. Bus, rapid transit
 3. Social Benefits and Costs 7. Time Costs
 4. Ridership, attraction

Abstract: The report is a comprehensive socio-economic evaluation of the proposed dual-mode transportation system for Milwaukee County, Wisconsin. The dual-mode concept involves bus transit vehicles capable of both fully-automated operation on a guideway and manual operation on city streets. The purpose of this report was to provide detailed comparisons between the dual-mode concept and conventional bus rapid transit with reference to ridership attraction and cost sensitivity.

A case study approach was employed to simulate patronage on the two alternative transit systems. A standard ridership forecasting approach was used to determine the relative advantages of conventional bus and dual-mode transit vehicles. The analysis revealed that a dual-mode system would: (1) attract approximately double the ridership of bus rapid transit, (2) provide reduced trip time [approximately 8% less], (3) improve accessibility by permitting the operation of six times as many routes, (4) change trip patterns, (5) reduce transfer requirements, and (6) improve driver productivity.

A cost effectiveness evaluation was then undertaken to compare both capital and operating costs for the two potential systems. A benefit-cost analysis was included in this process. The study revealed that costs associated with dual-mode transportation would be substantially higher than with conventional bus rapid transit. Annual operating costs were estimated to be approximately \$58 million and \$21 million, respectively; annual capital costs were \$46 million and \$12 million, respectively. The report also concludes that fares on the dual-mode system would have to be considerably higher. On the other hand, the benefit-cost analysis revealed that direct transportation benefits (eg. time savings, accident reduction, elimination of parking costs, etc.) would offset the estimated system costs. In addition, major indirect social benefits accrued from the dual-mode operation are likely to yield a substantial economic advantage.

The report examines the sensitivity of dual-mode operations to fluctuations in ridership, private transportation, and other independent variables. The authors conclude, however, that the operating economy of dual-mode transportation is not particularly sensitive to such variations, and that integration of the public transit system and private modes would yield a significant source of revenue to help defray operating costs. Sensitivity of the dual-mode operation to various service characteristics is also discussed.

The report concludes that a dual-mode transportation network will provide considerable benefits for transit users, transit operators, highway users, and the community at large. Appended material expands upon various analyses in the text and the analytical methods used.

NTIS Order #: PB-209-244
PC \$3.00, MF 95¢

Title: "Park-and-Ride Rail Service -- Jersey Avenue Station, New Brunswick, N.J."

Author: Tri-State Transportation Commission

Date: May, 1967

Project No. INT-MTD-1

Keywords: 1. Parking, park-and-ride
2. Parking, facilities
3. Parking, capacity and demand
4. Rail, commuter
5. Rail, stations and terminals
6. Center City
7. Intermodal Competition
8. Ridership, attraction
9. Suburbs, business districts
10. Traffic, congestion
11. Trip Generation

Abstract: The report summarizes a demonstration to determine whether a railroad station -- on the outskirts of a suburban city -- that offered convenient vehicular access and ample parking space would attract new patrons, divert passengers from an older station in the heart of the city (thereby reducing traffic congestion), and draw riders from other travel modes.

The site selected was a small modern station away from the commercial center of Brunswick, N.J., on the Penn Central commuter route to New York. The station was opened in an attempt to draw ridership from an older terminal facility in the city's congested downtown business district. Parking facilities were provided for some 300 cars at no cost to train riders over an 18-month demonstration period after which the railroad acquired the facility for continued service.

The authors note several problems which hampered realization of the project objectives. In one case, the number of trains serving Jersey Avenue Station was approximately half that serving the old downtown terminal. Also, despite its abundant parking capacity, the new station was not easily accessible for many New Brunswick commuters.

Various surveys were conducted to determine the extent to which park-and-ride facilities increased ridership both overall and vis-a-vis the old terminal. The conclusion was that although the Jersey Avenue station showed a continuing ridership increase, this was generally offset by increases in the volume overall. It was estimated that as much as 60% of new patronage consisted of new residents in the area and that up to 20% of the patrons were former bus riders. Additional survey data were obtained concerning trip generation and peak demand (which was found to be particularly pronounced).

The authors conclude that while the park-and-ride facility may not divert substantial ridership from an older station, it will attract new patrons to rail service. Furthermore, the appeal of an outlying station is related directly to the availability of convenient auto access routes and the frequency of train service.

NTIS Order #: PB-174-740
PC \$6.00, MF 95¢

Title: "Evaluation of Station Fare Collection System in Use at Kew Gardens and Forest Hills Stations of the Long Island Rail Road"

Author: DeLeuw, Cather & Associates

Date: September 30, 1965

Project #: INT-MTD-2

Keywords 1. Fares, collection 4. Rail, stations and terminals
2. Surveys 5. Rail, commuter
3. Community Response 6. Crime and Crime Prevention

Abstract: This report covers the Survey and Evaluation of Station Fare Collection Equipment used in the Mass Transportation Demonstration Project at the Kew Gardens and Forest Hills stations of the Long Island Rail Road.

The Kew Gardens - Forest Hills experiment was based upon an automatic fare collection system using a variety of tickets (single fares, ten-rides, monthly commutation, etc.) between two fixed locations. To reach a practical level of completeness, exit as well as entrance equipment was necessary; this is one of several elements which made possible the elimination of on-train ticket checking and thus made possible the first step in reducing cost of operation.

The equipment records the station of entry on prepaid station-to-station magnetically-coded tickets, and erases the correct increment of fare at the station of exit. On single-ride tickets, or on multiple-ride tickets which are used up, the exit equipment also captures the ticket. The author states that this station-to-station concept of automatic fare collection will probably prove adequate for many metropolitan area commuting systems; It is particularly applicable for single-line systems or for those with a relatively small number of trunk and branch lines.

In the Kew Gardens - Forest Hills trials, it became apparent that ordinary turnstiles will not be adequate for use in unattended stations. They provided neither adequate security nor sufficient speed of operation.

The author reminds the reader that in any system open to the public, vandalism must be given consideration. The most encouraging anti-vandalism factor regarding the automatic fare collection gates is that the reading and gate-actuating equipment contains nothing of value to the vandal; collection of money will take place in vending machines which can be built into solid walls and which will provide a greater degree of security than is possible in turnstiles or passenger gates.

The author reports the reception given the equipment by patrons of the Long Island Rail Road was generally favorable; he also reports favorable experience in the only other trial of similar equipment, at five passenger stations of London Transport.

Questionnaires and telephone and personal interview forms used in public response surveys, comments by passengers, passenger count analysis, a report to Technical Evaluation Committee, and brochures of June and December, 1964, concerning the Station Fare Collection Equipment, are included in an appendix to the report.

NTIS Order #: PB-173-473
PC \$6.00, MF 95¢

Title: "Suburban Service Adjustment Experiment"

Author: Tri-State Transportation Commission

Date: November, 1967

Proj. #: INT-MTD-5

Keywords: 1. Schedules and Scheduling
2. Trip Generation
3. Ridership, attraction
4. Parking, facilities
5. Community Response
6. Rail, commuter

Abstract: The purpose of this report is to determine if improved rail service--faster schedules, more frequent service, and expanded parking facilities -- will increase the number of additional journey-to-work and midday users in an "outer ring" suburban area. A mass transportation demonstration project on the Harlem Division of the New York Railroad was initiated to evaluate the effects of such improved rail service.

Project train service was begun on July 1, 1964. A speed-up in service was attained by adopting a skip/stop type of scheduling; six of the smaller stations north of the White Plains area were eliminated from the schedules of most trains. In addition, stops at stations below White Plains were removed from these same schedules. Initially, hourly off-peak service was provided by adding ten new Brewster/New York local trains. Also added were 12 trains--six in each direction between North White Plains and New York--to provide service at those stations removed from the Brewster/New York schedules. Subsequent schedule changes in April, 1965, resulted in 12 project trains operating between Brewster and New York, the four locals being discontinued. Parking facilities at six stations were expanded by more than 1,000 spaces. New parking lots were built by the State of New York, and a portion of the cost was reimbursed by a space-rental arrangement approved by the Dept. of Housing and Urban Development. A coordinated rail-bus service was also instituted to feed travelers from the upper, nonelectrified service areas to North White Plains, where maximum service was available.

When the plans of the Harlem Division Project were released to the public, a steady stream of complaints and court-suit threats was received. Project opposition, which stemmed from the towns that saw themselves adversely affected by the proposed schedules, led to a series of public meetings at which project proponents urged support of the experimental schedules. It was agreed to restore a few of the stops on peak-period trains at the skipped or nonexpress stations. At the beginning of the project's second year, several new elements were added. Two dual-powered locomotives were assigned to two popular commuter trains for a four-month period. This was done to determine the extent of expected running-time savings due to elimination of the wait for engines to be changed at the end of the electrified territory at North White Plains. Also, information about locomotive reliability in this type of service, as well as rail patron reaction to the service change, was gathered.

The principal findings of the experiment were: (1) More frequent service and expanded parking facilities in an "outer ring" suburban area will cause a substantial increase in journey-to-work and midday traffic. (2) Off-peak improvements will attract peak-period riders. (3) The coordination of feeder-bus and rail service in an area with high automobile ownership (85 percent) will not attract riders in sufficient numbers to support such bus service. (4) Capital improvements--including extension of electrification or substitute dual-powered equipment with electric acceleration characteristics--are necessary to produce significant travel time reductions.

NTIS Order #: PB-210-929
PC \$3.00, MF 95¢

Title: "Coordinated Bus-Rail Service: Rockland County, Westchester County, New York"

Author: Tri-State Transportation Commission

Date: January, 1967

Proj. #: INT-MTD-7

Keywords: 1. Rail, commuter
2. Bus, feeder
3. Intermodal Competition
4. Private Transportation, automobiles
5. Ridership, attraction
6. Schedules and Scheduling

Abstract: The purpose of this study is to determine if suburban rail patronage can be improved if feeder bus service from outlying urban areas is coordinated with the schedules of a rail service. It is thought that this is the best way to attract suburbanite commuters from the highways back to public transportation, especially for journeys downtown. To test this concept in the Tri-State Region of Connecticut, New Jersey and New York, a mass transportation demonstration project was designed to determine whether such a coordination of dual modes of travel would attract substantial journey-to-work and off-peak traffic when several alternatives were made available.

The area selected for the experiment was Rockland County, on the west side of the Hudson River, centered 35 air miles from the Manhattan Central Business District. The county lacked fast, convenient rail service direct to midtown Manhattan, and alternate modes of travel-the bus and private automobile- provided most of the transportation to the city. The automobile, with the advantage of two limited access highways, was much more popular. The bus route selected for the test began at New City, the seat of Rockland County government, and terminated at the Tarrytown station just across the Hudson River. The experimental bus service constituted an expansion of the existing limited schedules, with the same bus operator providing the service. Twenty-four daily round trips were scheduled for Monday through Friday, twelve during peak periods and twelve during midday and evening hours. The peak hour service was planned to meet the popular commuting trains to and from Grand Central, and the routes were realigned to provide some express service to Tarrytown. Substantial traffic was attracted to the project bus service. Patronage grew steadily throughout the first year of the demonstration, from a daily average of better than 200 riders in both directions during the initial weeks of the new service to a high of 467 in September, 1964.

The findings of the project were: (1) A feeder bus service in a low density suburban area, providing fast, frequent and accessible service, and coordinated with rail service to a major employment center, will attract substantial traffic. (2) Typical of travel between suburbs and city, however, this traffic will be oriented to work trips, and will be of an unbalanced nature, heavily one-directional in each of the traditional morning and evening peak periods. (3) The location of a core terminal which provides convenient access to places of employment will exert an affirmative influence on the passenger's choice of route when several alternatives are available. The results of the experiment suggest that a feeder bus service which is essentially of a short-haul nature, must find substantial off-peak use or be subsidized if it is to provide peak-hour shuttle service at a reasonable cost to the user.

NTIS Order #: PB-174-313
PC \$6.00, MF 95¢

Title: "The Radial Express and Suburban Crosstown Bus Rider" Final Report

Author: W. C. Gilman & Company, Inc. (for Bi-State Transit System)

Date: 1966

Project #: INT-MTD-8

Keywords: 1. Suburbs
2. Bus, express
3. Surveys
4. Land Use
5. Advertising and Promotion
6. Market Research
7. Center City
8. Demography

Abstract: This report summarizes a project to determine the criteria which influence the patronage of express bus operations and to test the feasibility of a cross-county bus route serving commercial centers which are developing outside the central city area.

The data collection and analysis phases of the demonstration consisted of a Home Interview survey of approximately 8,000 interviews; an "on-the-bus" rider survey of approximately 1,200 interviews; quarterly riding (on-off) traffic checks covering all trips on the project routes; specialized studies including surveys of residential areas, business areas, etc.; evaluation of operational data, including growth patterns; and revenue and operating statistics studies.

The demonstration project itself consisted of the establishment and the operation for a one-year period of seven new radial express bus routes between suburban residential areas and the central business district of St. Louis, and a new cross-county local bus service providing direct transit connections between two rapidly developing commercial centers. Selection of the routes was intended, the author points out, to provide a cross-section of land use in the environs of a moderate to large city of about 1,500,000 population. The radial routes were selected to provide direct downtown express service to areas not previously served, or served only by feeder or local services.

Prior to inauguration of service, an extensive promotional campaign, involving news stories, advertising and house-to-house distribution of schedules and complimentary tickets, was undertaken. The author states that the campaign had excellent results in acquainting the public with the availability and usefulness of the new routes.

From an operating standpoint, the author relates, operations went smoothly throughout the entire demonstration period; no problem of any magnitude appeared at any time during the project year. During the first two quarters and continuing into the third, riding on all routes continued to increase from the opening day total of 1,265 passengers; following the initial rapid growth, a period of continuing, though less marked, growth followed. The author notes that it became apparent that certain lines would never attain sufficient ridership to justify the service provided; permission was received to reduce service on certain routes.

NTIS Order #: PB-174-220
PC \$6.00, MF 95¢

Title: "A Survey to Evaluate the Criteria Which Influence the Purchase and Use of a Monthly Transit Pass and to Determine Reasons Why Transit Non-Pass Riders Do Not Purchase a Pass"

Author: W.C. Gilman & Company

Date: December 11, 1964

Project No. INT-MTD-9

Keywords: 1. Fare, passes
2. Surveys
3. Traffic, peak-hour
4. Ridership
5. Trip Generation

Abstract: The report analyzes the use of \$12 monthly fare passes by transit riders in the St. Louis metropolitan area. Two separate fare passes were employed in the demonstration -- one in each of the area's major fare zones. Passholders were permitted an unlimited number of rides on most transit routes; a slight additional charge was collected for trips outside the fare zones and for express service. The passes could also be used by persons making trips in either fare zone; passholders were exempted from having to pay the bridge fare (for trips which crossed over the Mississippi River) which was otherwise collected from cash-paying passengers.

The report documents the results of detailed surveys undertaken to determine the reasons why passengers did and did not purchase the monthly passes. Complete statistical data and other relevant material are outlined in the report.

The surveys indicated that the use of fare passes increased 78% during the demonstration. Pass users were principally rush-hour commuters who made frequent use of public transportation; respondents in this category usually bought passes for the sake of convenience and economy. The authors also conclude that since more than 12% of all passholders were not previously regular transit riders, the pass helped to stimulate overall ridership. The surveys revealed that most non-passholding respondents were infrequent transit riders for whom the unlimited-ride provision was of marginal economic value.

NTIS Order #: PB-174-420
PC \$6.00, MF 95¢

Title: "Transit Information Aids" (Final Report)

Author: Washington Metropolitan Area Transit Commission

Date: UNDATED

Project No. INT-MTD-10

Keywords: 1. Information Aids
2. Public Relations
3. Ridership, attraction
4. Signs and Signals
5. Maps and Mapping
6. Social Benefits and Costs

Abstract: The report summarizes a demonstration of transit information aids in the Washington, D.C. area. The five-phase project covered organization and surveying, designing of the aids, production and installation, field testing, and final evaluation.

During the initial project phase, Washington residents and transit users were surveyed to determine existing attitudes and informational needs. Of several possible information aids which were designed during Phase II, only three were actually implemented for the demonstration. These included: (1) bus stop markers, (2) a route indicator for buses, and (3) a timetable folder. More than 300 bus stop markers were installed along with appropriate route markers on 29 buses; more than 150,000 timetables were distributed. Follow-up surveys were used to assess the impact of these devices and the responses to them.

Initially, the authors developed seven basic hypotheses concerning the effect of improved information aids on overall transit ridership and public opinion. Specifically, they postulated that the project would: (1) increase the number of riders using more than a single route, (2) improve public attitudes toward transit, (3) increase the predisposition to use transit, (4) increase knowledge of other sources of information, (5) increase knowledge of the transit system as a whole, (6) decrease satisfaction with information currently offered, and (7) improve the quality of information given by transit employees.

The short testing period and the influence of external events (eg. civil disorders, a fare hike proposal, maintenance problems, etc.) hampered the synthesis of definitive conclusions. The authors conclude that none of the hypotheses above were clearly validated. The data indicate, however, that people do accept and use new information aids when they are made available. In addition, the report notes that the tendency of riders to use a limited number of bus lines for specified, repetitive purposes suggests that efforts to increase the number of people who use buses should focus more on information aids for regular riders than for occasional users.

NTIS Order #: PB-196-329
PC \$3.00, MF 95¢

Title: "New Haven Railroad Commuter Service"

Author: Tri-State Transportation Commission

Date: May, 1970

Proj. #: INT-MTD-11

Keywords: 1. Fares, cost determination 3. Benefit-Cost Analysis
2. Rail, commuter

Abstract: The purpose of this report is to describe the existing fare structure of the New Haven Railroad Commuter Service, and the resulting pattern of ticket use. Also discussed is the effect of fare structures on the railroad's net revenue position.

Fares on the New Haven Railroad have remained unchanged since 1962 but are still generally higher than those on most other railroads in the Tri-State Region, particularly for long-distance, monthly tickets. The present fare structure of the railroad has five basic types of tickets: one-way; 30-day, round-trip; two-day, round-trip; 60-day, ten-trip; and monthly, 46-trip.

The one-way ticket, which forms the basis for the entire structure, is priced at a system-wide rate of about five cents per mile. The 30-day, round-trip ticket is 180 percent of the one-way fare or 4.5 cents per mile. The two-day, round-trip ticket is 180 percent of the one-way, or 4.5 cents per mile. The 60-day, round-trip ticket is the one-way fare plus a flat additive of 55 cents, which works out to 2.5 cents per mile plus 27 1/2 cents. The ten-trip ticket is pegged to the two-day, round-trip by adding five cents more per trip, except beyond Bridgeport where the rate jumps to five cents per mile. Finally, the monthly commuter ticket costs 1.9 cents per mile plus a flat charge of 32 cents per trip, assuming a passenger travels 40 times during the 30-day period. The face value price is 1.6 cents per mile for the 46 trips allowed on the ticket, but average use is the 40 trips assumed in this analysis.

The characteristics of passenger travel in the New Haven's West End area are primarily commuter oriented to or from New York City; 92 percent of all trips made within the West End area start or end in New York City. The distance travelled in an average trip is 31.3 miles, and the passenger pays \$1.22 on the average for his trip. On a normal weekday during 1964, nearly 29,000 passengers travelled to Manhattan on the railroad. An additional 3,000 used the railroad locally, not going into the city. Revenues from all West End passenger services totalled \$28 million for 1964, and an additional \$9 million was credited to the West End area for long distance service which passes through it. The average New York round trip in the West End area, including all types of tickets, now generates approximately 3.9 cents per mile. Revenue per passenger has increased slightly during the past few years as the distance travelled has gradually increased. The large increase in average revenue per passenger between the years 1961 and 1964 results primarily from the ten percent fare increase which went into effect early in 1962. There was no change in fares in the 1964-1966 period.

The amount of future travel on the New Haven will be determined in many ways by the level and type of fares to be charged. The greater the number of people that it is desired to have use the railroad, the lower the fares should be. However, this demand is not unlimited, and even if there were no fare, only a certain maximum number of trips would be made.

The authors project that work trips to Manhattan will increase in the future, particularly from areas 30 miles or more from Manhattan. Total trips are expected to increase about 29 percent by the year 1985 from the present level, assuming the proposed modernization program is completed.

NTIS Order #: PB-194-825
PC \$3.00, MF 95¢

Title: "The Turbo - Electric Rail Car: Technical Report"

Author: Louis T. Klauder and Associates

Date: March, 1971

Proj. #: INT-MTD-12

Keywords: 1. Propulsion Systems, electric 4. Quality Control
 2. Rail, rolling stock 5. Propulsion System, turbines
 3. Dual Mode Systems 6. Power Distribution

Abstract: This report concerns tests conducted to determine the benefits of high horse-power-to-weight ratios and presumed ease of maintenance inherent in the modern gas turbine engine as applied to railroad passenger cars. The report also explores the possibility of a dual-power car drawing power from a third rail or its own power plant. The tests offered an opportunity to develop and test a chopper controlled propulsion system.

The tests were a sequel to an extension of the 1966-67 tests of a suburban passenger car (a single-mode vehicle) with a turbo-mechanical drive. The vehicles, directed toward suburban service having electrified tunnel access to Manhattan at one end and lines of insufficient density to justify electrification at the other, retained the flexibility of multiple-unit car operation.

The author states that the results of these tests indicate that: (1) The concept of a dual-mode commuter rail car, capable of operation on both third rail power in non-electrified territory, warrants further investigation; and (2) The ability of the car to operate on third rail power offers the additional advantage of enabling the car to operate in tunnels approaching New York City terminals where use of internal combustion systems is prohibited.

NTIS Order #: PB-201-909
PC \$3.00, MF 95¢

Title: "Test of Turbo-Electric Rail Car -- A Summary Report on Part Two of the Mass Transportation Demonstration Grant Project"

Author: Tri-State Regional Planning Commission

Date: December, 1971

Project No. INT-MTD-12

Keywords: 1. Rail, rolling stock
2. Rail, commuter
3. Dual-Mode Systems
4. Testing Facilities
5. Propulsion Systems, turbines
6. Propulsion Systems, diesel
7. Propulsion Systems, electric

Abstract: The report summarizes tests of a dual-mode, gas-turbine, electric rail car to evaluate its potential for high-speed commuter service in the New York City metropolitan area. The car was designed to operate on both electrified and non-electrified track, and thus permit the extension of existing services into areas where the costs of providing wayside electric power are prohibitive. The propulsion unit combined two separate systems: (1) a diesel-powered turbine, and (2) electric traction with "chopper" voltage controls. This demonstration expanded upon earlier tests of a vehicle equipped with turbo-mechanical drive.

The report documents all relevant details of the testing program with reference to instrumentation, procedures, and specific results. Some results were deemed inconclusive due to malfunctions of the modified prototype components. The authors conclude, however, that running performance of the dual-mode vehicle was competitive with conventional rolling stock; the transition between propulsion systems yielded no operational difficulties. In addition, the demonstration indicated that the use of turbine power should prove acceptable to passengers, the wayside public, and railroad personnel. Because the testing program could not study reliability factors or maintenance requirements, no economic evaluation could be made.

NTIS Order #: PB-208-231
PC \$3.00, MF 95¢

Title: "A Systems Analysis of Transit Routes and Schedules"

Author: Alan M. Voorhees and Associates, Inc.

Date: November, 1969

Proj. #: INT-MTD-14

Keywords: 1. Computer, programming
2. Computer, applications
3. Routes and Routing

Abstract: The purpose of this study is to investigate the feasibility of applying a series of computer programs developed by Alan M. Voorhees & Associates, Inc. to assist the Housing and Urban Development Department in formulating long-range plans for public transit systems. These programs permit rapid codification of a real hypothesized transit network in a form that can be readily input into the computer. The computerized representation of the network thus provides the framework for computer simulation and analysis of the transit system. One of the primary objectives of this study was to determine if simulation of a transit system through computer methods could be effectively used as a tool for short-range transit route planning. Since the system to be studied was the D. C. Transit System covering the District of Columbia and nearby suburban Maryland, a further objective of the study was to devise an improved route and operating plan for that system.

The early stages of the study consisted of gathering and processing for analysis two basic sets of data. One of these was an accurate description of current travel patterns by patrons of the D. C. Transit System. The source of these data was a passenger origin-destination survey conducted in the Washington area in 1966. The data from this survey, which described inbound trips only, were adjusted to reflect travel in both directions. The second basic data set consisted of the current operating characteristics of the transit system. These included route locations, bus headways, bus speeds, operating cost data, and field-counted passenger volumes. The first three of these items served as inputs for representing the current D. C. Transit network in the computer format required by the HUD Transit Planning Programs. Using the travel pattern data, this simulated network was then calibrated. Later a more simplified network termed the Basic System was prepared. The first step in the evolution of an improved bus routing system is the development of alternative systems. To gain full advantage of the systems techniques used, alternative route systems were developed in succession, with each system building upon the experience gained in the preceding ones. Following this procedure, two different alternative systems were successively developed and analyzed. This led to the development and study of a third and final system, termed the Optimum System.

When the Optimum System was compared to the Basic System the following significant findings emerged: (1) Travel time was reduced for 26 percent of peak riders and lengthened for only 9 1/2 percent. (2) Travel time was reduced for 25 percent of midday riders and lengthened for only 8 percent. (3) Number of peak trips involving transfers was reduced 12 percent. (4) Number of midday trips involving more than one transfer was reduced 37 percent.

NTIS Order #: PB-189-269
PC \$6.00, MF 95¢

Title: "The Scrip System of the D. C. Transit System: Washington, D. C."

Author: Washington Metropolitan Area Transit Commission

Date: June, 1970

Proj. #: INT-MTD-15

Keywords: 1. Fare, collection 4. Advertising and Promotion
2. Crime and Crime Prevention 5. Community Response
3. Bus, driver

Abstract: The purposes of the project were to determine the feasibility of issuing scrip or redemption coupons to bus passengers as change in lieu of cash, to test whether this modified fare system would eliminate robberies of bus drivers, to study what effects the system would have on carrier operations, and to discover if the system would be accepted by the public.

In Washington, as in most cities, bus service operated on a cash basis. Many Washington drivers were required to carry as much as 100.00 to 175.00 dollars in cash to make change for passengers who boarded the vehicle without the exact fare. This sum was large enough to be attractive to petty, but often vicious, thieves. However, an obvious deterrent to bus robbery is for drivers to carry no cash. Consequently, two needs are apparent: some form of change must be available to the small percentage of passengers unable to present exact fare in cash or tokens; tokens must be readily available to patrons at off-bus locations.

The Issuing Scrip system was initiated. This system allows drivers to issue, in lieu of change, redeemable coupons to passengers boarding with coins or bills in excess of the local or interline fares; the amount of money received from the passenger is deposited into a securely locked box which cannot be opened by the driver.

The Scrip system was tested both during the daytime and the nighttime; the response from the public and private sectors of the community was supportive.

Token distribution was increased as a convenience for riders who preferred to use the tokens rather than pay the exact fares; however, this method was soon abolished after the price of tokens was increased and the sale of tokens on buses was halted.

Public acceptance was the single most important factor in the successful use of the scrip system. Extensive efforts were made to inform the public of the objectives and workings of the new scrip. Flyers were issued explaining the system; signs were posted in and on the buses; "Exact Fare Only" was clearly marked on fareboxes; and, in addition, newscasters on radio and television stations carried spot announcements and editorials about developments in the new system. The newspapers were equally constructive in their comments.

Reviewing this situation, the Washington Metropolitan Area Transit Commission (WMATC) felt that the only segment of the public for whom the scrip redemption system might constitute an inconvenience of any magnitude was the tourist population. For out of town visitors, the amount of refund would not be worth the time, effort, and expense involved in going to a redemption center.

The report also cites the problems and experiences incurred by other cities who have implemented an exact fare system of fare collection.

NTIS Order #: PB-194-958
PC \$3.00, MF 95¢

Title: "The Capital Flyer Bus Service Between the District of Columbia and Maryland and Virginia Counties in the Washington Metropolitan Area (Final Report)"

Author: Washington Metropolitan Council of Governments

Date: November, 1971

Project No. INT-MTD-17

Keywords: 1. Bus, commuter
2. Bus, rapid transit
3. Suburbs
4. Center City
5. Inner City
6. Ridership, attraction
7. Employment
8. Fare, cost determination
9. Fare, reduction
10. Parking, Park-and-Ride
11. Advertising and Promotion

Abstract: The report summarizes a demonstration of two-directional bus rapid transit conducted over an 18-month period in the Washington, D.C., metropolitan area. Two principal objectives of the project were to: (1) demonstrate the attractiveness of specialized commuter bus service to suburban residents in a major urban area; and (2) provide transportation access to outlying employment opportunities for inner city residents to whom adequate and dependable mobility was not otherwise available.

The project operated peak-hour rapid bus service between the Washington, D.C., central business district and three suburban counties in neighboring Virginia and Maryland. The report documents all relevant aspects of the demonstration with reference to: (1) a description of the project area and lines operated; (2) project development and in-service improvements; (3) ridership profiles of suburban and inner city commuters; (4) suburban employment opportunities; (5) promotional and informational activities; and (6) complete ridership, operating, and financing data.

Suburban terminals were selected to maximize the availability of low-cost parking in order to encourage regular automobile commuters to utilize the public mode; in this respect, the use of peripheral parking facilities at shopping centers proved effective. Fares were kept low (25¢ initially) as a further inducement to potential ridership and to make the service available to low-income residents of the center city. In-service fare increases were found to have a markedly negative effect on ridership, although overall patronage remained stable and high throughout the demonstration.

One particularly important aspect of the project was an attempt to develop employment opportunities in the suburban areas and to encourage reverse-commuters to utilize the buses. State and local employment agencies cooperated by seeking jobs for low-income inner city residents in suburban job centers, but the report concludes that overall results were unsatisfactory.

The report concludes that all suburban commuter lines were highly successful, including those in high-income neighborhoods with ingrained car commuting habits. Suburban commuters were particularly attracted by the convenience of loading and discharge locations, schedules tailored to work hours, and the availability of free parking facilities. All of these lines have since been retained by the existing private bus companies. On the other hand, the demand from reverse (city-to-suburb) commuters was insufficient to warrant continuation of the service after completion of the demonstration period. The authors cite difficulties in developing suburban job opportunities as having posed a major problem.

NTIS Order #: PB-206-408
PC \$3.00, MF 95¢

Index No. 1-INT-17.1

Title: "Evaluation of City Transit Bus 'E.I.P.' Kits to Reduce Engine Smoke, Odor, Noxious Emissions and Noise"

Author: G.F. Swetnam and F.L. Willingham (The Mitre Corporation)

Date: August, 1971

Project No. INT-MTD-20

Keywords: 1. Air Pollution
2. Noise and Noise Control
3. Bus, design
4. Fuel, injection
5. Propulsion Systems, diesel
6. Mufflers
7. Environment and Environ. Control

Abstract: The report summarizes results of a demonstration to test and evaluate bus "EIP" (Environmental Improvement Program) kits in two major metropolitan areas. The EIP kit was developed in 1969 by General Motors Corporation as a device to reduce the engine smoke, odor, noxious emissions and noise produced by transit buses.

Available EIP equipment can be applied to most of the 24,000 "new look" transit vehicles produced since 1959 which comprise the most active part of our national fleet. Although the entire kit cannot be applied to some 22,000 buses produced earlier, its most effective component, the LSN fuel injector, can be fitted with highly beneficial results. At present, approximately 300 new buses have factory-installed EIP equipment; 39 existing vehicles were outfitted with kits for the present demonstration project.

The report describes EIP hardware in detail. Its five major components include: (1) a redesigned needle-type LSN fuel injector; (2) a vertical, aspirated exhaust stack; (3) a muffled air induction system; (4) energy absorbing engine mounts; and (5) an exhaust heat activated, catalytic reactor incorporated into a new muffler. The authors focus particular attention on the LSN injector system. During combustion, residual fuel remaining in the conventional injector tip tends to burn incompletely and is believed to be a major source of unburned hydrocarbons and smoke. The redesigned LSN injector contains residual fuel below the needle valve and can thus eliminate a substantial amount of pollutant emissions.

Two demonstration projects funded by the Urban Mass Transportation Administration were undertaken to test and evaluate EIP performance in urban operations. These were carried out under auspices of the Washington (D.C.) Metropolitan Area Transit Commission and the San Francisco Public Utilities Commission. Results indicated measurable reductions in smoke, odor, noxious emissions, and (some) noise produced by buses equipped with EIP kits. The authors note that existing Federal anti-pollution standards, which regulate permissible smoke levels, can already be met by conventional buses if properly maintained. Proposed emission standards for heavy-duty diesel engines in California, however, also regulate levels of carbon monoxide, hydrocarbons, and nitrogen oxides. Buses equipped with EIP kits are likely to pass the California standards proposed for 1973, but because the kits do not appreciably reduce emissions of nitrogen oxides, they will probably fail the standards proposed for 1975.

The report contains individual performance evaluations for each EIP component and a brief discussion of cost considerations for fleet applications.

NTIS Order #: PB-204-813
PC \$3.00, MF 95¢

Index No. 1-INT-20.1

Title: "Report on Urban Mass Transportation in Metropolitan Mobile, Alabama, Including Valuation Supplement"

Author: Coverdale & Colpitts

Date: January 9, 1970

Proj. #: ALA-T9-1

Keywords: 1. Financing Mass Transp., requiremts. 5. Government, Urban
2. Routes and Routing 6. Government, Federal
3. Government, Taxation 7. Advertising and Promotion
4. Government, State

Abstract: The purpose of this study is to examine the need for public transportation in the Mobile area and the feasibility of public acquisition and operation of the Mobile City Lines, Inc. bus system. Late in February the Mobile City Lines, Inc. notified the City that it would cease all transit operations as of March 5. To prevent the hardships and disruption caused by sudden loss of public transportation, the City acted promptly to ensure its continuance. The City of Mobile enlisted the services of the authors to advise and assist in the reorganization of the transit system for public operation.

An evaluation of the assets and operations of Mobile City Lines, Inc. indicated that the operating facilities are both suitably located and satisfactory for the continued operation of the system. The bus fleet is generally in satisfactory operating condition, and while certain of the older units should be replaced with new equipment, the fleet as a whole is adequate for operations in the immediate future.

The authors recommend that the most logical method of perpetuating transit in Mobile would be through public ownership and operation of the system. Public ownership carries a number of advantages not available to the private operator. Tax relief from most Federal, state, and local levies is available. Federal assistance in the form of funds for improvements, capital expenditures, and demonstration projects is also available to qualifying public bodies.

The researchers also advocate the development of an effective demand-responsive type of transit system. This would involve the initiation of a vigorous continuous process of route modification and development as well as charter and special service expansion, designed to satisfy the transportation needs of the area. To attract, stimulate, and maintain the interest of the public in the revitalized transit system, an imaginative advertising and public relations program would be employed.

NTIS Order #: PB-197-963
PC \$3.00, MF 95¢

Title: "Areawide Mass Transit Planning Study - Planning Series Report # 5:
Plan Development"

Author: Tucson Area Transportation Planning Agency

Date: January, 1970

Project #: ARIZ-T9-2

Keywords: 1. Government, urban 4. Qualitative Analysis
 2. Management 5. Public Ownership
 3. Surveys

Abstract: This report presents historical data on Tucson's growth and development, discusses present mass transit facilities and their uses, examines the national scene with respect to Federal programs and the experience of other cities, and concludes with recommendations for continuing transit service in the Tucson area. A supplement augments the report in furnishing a detailed reporting and documentation of the procedures and results of the field surveys that were accomplished as part of the data collection phase of the technical studies; included is information on three separate surveys: on-bus surveys, an areawide sample survey, and a model cities sample survey.

Public mass transportation is a necessary and desirable ingredient in the Tucson community; it should be established as a dependable and continuing service, provided from a single regional operation that serves all parts of the community. Adequate areawide mass transit service in Tucson cannot be operated at a profit (Government should take positive steps to ensure the continuance of the service and must share with the user the cost of providing the service.); it should be publicly owned and publicly or privately operated. A regional transit authority should be established under the authority of new state legislation, and a source for funding the transportation should be established.

An efficient bus route system should be established which provides more frequent service to the areas of highest demands; hourly service, as provided in 1969, would not be adequate, and would contribute to the trend of declining bus patronage if allowed to continue. The most suitable bus for regular route service in Tucson is a 33-passenger diesel-driven vehicle; the factors given prominence in this choice were: initial capital cost, maintenance costs, operating costs, life of equipment, suitability to type of service to be provided, and general appearance and comfort to passengers.

It is important to operate clean, comfortable, and attractive buses; the retention of current riders and the attraction of potential users to the system are affected by the quality of the equipment. The purchase of a new fleet of buses should be undertaken and the fleet should be maintained in a condition of high quality. In addition, a comprehensive program of bus stop improvements should be undertaken; adequate marking, appropriate spacing, provision of benches and/or shelters, and removal of conflicts with other vehicles should be among the items on which to concentrate. Further, a central bus stop should be established in the central business district; the area should be planned and designed to provide an attractive, comfortable environment for waiting bus patrons.

The author recommends that an aggressive market research and public relations program be established by the regional transportation authority; a new image for public transportation, he suggests, should be shaped, and potential areas of expansion of services should be continually researched.

NTIS Order #: PB-191-123
PC \$3.00, MF 95¢

Title: "Areawide Mass Transit Planning Study - Planning Series Report #5:
Plan Development; Supplement A; Field Surveys"

Author: Tucson Area Transportation Planning Agency

Date: January, 1970 Proj. #: ARIZ-T9-2

Keywords: 1. Surveys 4. Employment
2. Urban Development, renewal 5. Poverty
3. Ridership, profiles 6. Qualitative Analysis

Abstract: This supplemental report to the "Areawide Mass Transit Planning Study" provides a detailed reporting and documentation of the procedures and results of the field surveys accomplished as part of the data collection and analysis phase of the technical studies. Detailed data are presented for the following three separate surveys: (a) on-bus surveys, (b) an areawide sample survey, and (c) a Model Cities sample survey.

Two on-bus surveys were made. Each person boarding a Tucson Transit Corporation bus during the first survey was handed a card (which briefly explained the purpose of the survey and asked for cooperation), an interview card, and a pencil, and was asked to complete the questionnaire and return it to the interviewer when leaving the bus. The second on-bus interview consisted of handing to the boarding rider a book of consecutively numbered trip tickets and ticket stubs that were returned to the interviewer when the rider left the bus. Spaces were allotted to mark the zones in which the customer boarded and left the bus, the type of fare collected, if a transfer was issued upon boarding, the final destination of transfer passengers, the bus route, the direction of travel, and the time of day.

In order to acquire current data on travel characteristics, to obtain knowledge of the general public attitudes relating to urban travel and public needs, and to identify the market potential for increased transit patronage from responses to questions on travel habits, travel needs, and attitudes, a home interview (Areawide Sample Survey) was designed and implemented, covering a one-percent sample of dwelling units randomly drawn from some 90,000 units.

An area of approximately five square miles immediately west and south of the Tucson central business district comprises the Tucson Model Cities Area; the area is presently characterized by a combination of severe urban problems such as high unemployment, low family income, accelerated structural blight, and other social and economic problems. In an effort to determine the degree to which the availability or non-availability of transportation may be contributing to the problems of the area, a special transportation-oriented questionnaire was designed to collect information from a six-percent sample of area households selected on a block-cluster basis. The survey was governed by a door-to-door field interviewing technique.

The bulk of this report is comprised of tables and figures showing the types of questionnaires used in the various surveys, profiles of the public interviewed, the types of questions asked, and the types of responses received.

NTIS Order #: PB-191-124
PC \$3.00, MF 95¢

Title: "Phoenix Urban Area Public Transportation Study"

Authors: DeLeuw, Cather & Company

Date: July, 1971

Proj. #: ARIZ-T9-3

Keywords: 1. Ridership, profiles 4. Management, planning and analysis
2. Fares, cost determination 5. Government, state
3. Routes and Routing 6. Public Ownership

Abstract: The purpose of this study was to develop a public transit service program for the City of Phoenix. Public transportation services in the City of Phoenix and the surrounding urban area have been provided by several operators, of which the Phoenix Transit Corporation (PTC) was the major one and had the largest patronage. Over the past several years rising expenses and declining ridership necessitated service cuts and fares increases. In spite of these measures the financial status of the PTC continued to deteriorate. On March 1, 1971, the City of Phoenix entered into a contract with the PTC, in which the latter agreed to continue operating its transit service on behalf of the City for a negotiated fee.

Among the different transit operators in Phoenix, there is very little coordination of schedules, fares, and other operating features. The patronage level of public transportation is low, with only 12,000 passenger trips being generated on a weekday. However, transit represents a vital service to persons who cannot or do not want to drive and to high school students in the Phoenix Union High School District.

The basic fare structure for one ride on any of the PTC routes is 35 cents, applicable to persons over 11 years old. The basic fare for children from 6 through 11 years is 30 cents. Children under six are transported free of charge. The distance a rider may travel for the basic fare is approximately 2.5 miles in any direction from downtown Phoenix. Beyond this, the rider must pay an additional fare, which increases in three 5-cent increments, commensurate with the distance traveled, bringing the maximum fare to 50 cents. The bus routes in Phoenix form a radial pattern emanating from downtown. From an operational point of view this pattern is very convenient because it facilitates scheduling, linking of routes for bus assignment purposes, and transferring of passengers at one location. However, the radial arrangement presents an inconvenience for those patrons who do not have downtown as their ultimate destination, but desire to travel crosstown either in a north-south or east-west direction.

The authors recommended that steps be taken to reduce costs to users of the system. The present transfer fee of five cents should be eliminated and the number of zones reduced from the present four to two. The transit authority concept should be adopted as the form of public management for a transit system in Phoenix. Since present transit authority legislation has been found unconstitutional, the Arizona State Legislature should be urged to enact appropriate transit legislation. The authors also recommended the restructuring of the present route system.

NTIS Order #: PB-204-398
PC \$3.00, MF 95¢

Title: "A Study of the Public Transit System Operating in the Little Rock/North Little Rock Area"

Author: Snavelly, King & Tucker, Inc.

Date: May, 1971

Proj. #: ARK-T9-1

Keywords:	1. Bus, intracity	6. Government, taxation
	2. Bus, cost	7. Public Ownership
	3. Government, Federal	8. Surveys
	4. Government, urban	9. Community Response
	5. Financing Mass Transportation, requirements	10. Management, operations and techniques

Abstract: The report is a comprehensive technical study of mass transportation in the Little Rock and North Little Rock, Arkansas, area which is characterized by a common profile of declining patronage and rising costs. The authors note the importance of transit to the area and therefore attempt to synthesize a recommended program for revitalizing service. Of particular concern throughout is the substantial deficit incurred by present operations and the need for innovative financial and managerial alternatives.

The report begins with a brief regional socioeconomic profile and results of a survey to determine public attitudes and desires. Survey methodology is described in detail along with community response data collected at Model Cities meetings. Four general issues were revealed to be of primary concern, including: (1) service improvement, (2) alleviation of the operating deficit, (3) alternative ownership schemes, and (4) the impact of service discontinuances on the community.

General characteristics of the transit system are outlined with reference to equipment, ridership trends, routes and scheduling, manpower, maintenance operations, and information services. The authors recommend continued acquisition of new rolling stock, improved routing to serve major trip generators, scheduling to reflect demand peaks, and renegotiation of labor contracts to permit hiring of part-time drivers for school and charter bus operations. The report also analyzes existing sources of transit revenue and compares them with projected operating costs and depreciation schedules. The authors conclude that the private sector cannot support adequate levels of service and that some public subsidy must be provided. Transit marketing techniques are examined with reference to promotional campaigns, fare structure, and potential markets for expanded service.

The report considers alternative management and ownership options, and concludes that out-right discontinuation of service will ultimately extract greater social costs than the provision of public assistance. The recommended management alternative entails acquisition of transit assets by a regional authority. Ownership by the City and formation of a Council of Governments to overcome political problems generated by rival jurisdictional entities are other alternatives considered in the report. Potential sources of financial assistance for the transit authority are outlined with reference to taxation, revenue bonds, special assessment bonds, and general subsidization. Three relevant sources of Federal assistance are also discussed, including special transportation revenue sharing, Model Cities funding, and urban transportation planning grants.

The report concludes with a long-range capital improvement proposal embracing the acquisition of new rolling stock, purchase of a competitive transit company, relocation of maintenance facilities, installation of radio communications devices, and renovation of passenger shelters and bus stop signs.

NTIS Order #: PB-203-860 -U
PC \$3.00, MF Not Available

Title: "Santa Clara County Transportation Planning Study - Final Report"

Author: County of Santa Clara, Transportation Policy Committee

Date: April, 1969

Project #: CAL-T9-7

Keywords: 1. Bus, intracity
2. Rail, commuter

3. Demography
4. Intercity Transportation

Abstract: This report is a summary of the major findings, conclusions, and recommendations resulting from the Santa Clara County Transportation Planning Study (SCCTSPS). The study dealt primarily with intra-county travel and the local area factors that produce travel. Inter-county travel is a serious local problem; regional facilities serve not only inter-county trips, but many trips that are entirely local in nature.

Although Santa Clara County is a major urban area, its land use development is essentially suburban in style. Residential development is low in density, primarily single-family homes, spread throughout the valley. Commerce, industry, education, and recreation is broadly dispersed. Santa Clara County is one of the fastest growing areas in the nation, but a survey of community attitudes regarding style of living shows preferences that indicate a continuation of trends for low density residential development and further dispersal of other land use activities. Most of the economic activity as characterized by travel is contained within the county; travel within the county is dispersed, with widely scattered trip origins and destinations. The vast majority of trips are by private automobiles; transit service is limited in scope and carries less than 2% of total weekday trips. The dispersed travel in the county has nothing in common with city boundaries and makes a unified, area-wide approach essential to the planning of transportation systems.

Under current circumstances, the automobile is the most convenient form of transportation for most purposes and will be used for the majority of trips. Despite the preponderance of automobile travel, a transit system is needed by a significant portion of the population. An examination of transportation technology leads to the conclusion that no ideal method has yet been invented for moving great masses of people about within urban areas without delay and inconvenience at some point in the journey. Therefore, it can be expected that transit in Santa Clara County will supplement the automobile transportation system, but not replace it.

Findings of the SCCTPS support the conclusion that success of any kind of transportation mode in Santa Clara County lies in the presence of a system network. A countywide public transit service would be established, initially using buses; buses can be placed into service at an early date. In addition, buses enjoy flexibility and costs within local financial means. Configuration of intra-county travel based on the land use patterns does not justify the high cost of an extensive local rapid transit system; local resources are not adequate for rapid transit financing. The logical first unit of rapid transit service within the county should be a trunkline for regional connections; a detailed engineering analysis, made cooperatively with Bay Area Rapid Transit District and West Bay Area Rapid Transit Authority, is suggested. External funding will be required for development.

Changes should be made in the restrictions on State and Federal gasoline and motor vehicle taxes to permit more flexible planning for varying community needs; State and Federal Governments should establish transit research and funding programs equivalent in scale to road programs. Development should continue for freeways, expressways, and major arterials. The author recommends that implementation proceed on short-range programs and the county should maintain a flexibility for response to changes that may occur in the longer range: revision of policies for local development, technological breakthroughs, establishment of a Bay Area regional transportation agency, and increased external funding that could change the cost feasibility of rapid transit.

NTIS Order #: PB-203-135-U
PC \$3.00, MF Not Available

Title: "San Jose-Santa Clara County Bus Study" [Oversize Document]

Author: Wilbur Smith and Associates

Date: September, 1969

Project No. CAL-T9-7

Keywords: 1. Bus, intercity
2. Bus, commuter
3. Bus, school bus
4. Bus, cost
5. Government, county
6. Public Ownership
7. Ridership
8. Trip Generation
9. Modal Split
10. Routes and Routing
11. Surveys
12. Urban Development, planning

Abstract: The report is a comprehensive technical study of bus transit in the Santa Clara County metropolitan area. Although presently served by four independent bus companies, regional patronage has declined by 23% over the past five years. The purpose of the report was to describe all relevant aspects of the present system and to synthesize a recommended program for improving mass transportation in the county.

The report details existing transit facilities and operations with reference to route locations, route coverage, signing and spacing of stops, equipment and facilities inventory, organization and personnel, headways and schedule adherence, equipment utilization and load factors, average vehicle speeds, passenger volumes and trends, financial factors, and public attitudes. Attitude surveys revealed that a high percentage of area residents are dissatisfied with many aspects of the present service.

An analysis of existing travel habits yielded basic data concerning trip generation, traffic distribution, modal split, and other behavioral patterns. The report documents four surveys conducted among bus passengers, random households, employers, and persons residing in low-income areas. In addition, the authors examine school bus transportation within the various districts which comprise Santa Clara County. California bus-sing laws, school enrollments, illustrative case studies, and individual bussing characteristics are discussed. The authors conclude that school bus service should be coordinated on a regional basis to optimize service. Even so, a significant potential for the making of school trips on public transit is estimated.

The report focuses particular attention upon the future role of mass transit. Projections of regional population growth and modal split are compared; these data yielded three alternative bus systems. These are examined in detail with reference to forecasts of annual patronage and operating costs.

The recommended mass transit program is based primarily on public countywide ownership of the system. Design and implementation of the optimal route network under comprehensive management is described in detail. The authors also note equipment requirements, fare structure, route stops and terminal facilities, and other similar characteristics of the proposed system. The report also examines the potential for special bus routes through the San Jose central business district, related general traffic improvements, and operation of a "busway" system. Annual costs for the recommended plan are outlined along with estimated benefits to the surrounding community.

NTIS Order #: PB-191-127
PC \$3.00, MF 95¢

Title: "Transit Planning Study: City of Mountain View"

Author: De Leuw, Cather & Company

Date: October 26, 1970

Project No. CAL-T9-7

Keywords: 1. Bus, intracity
2. Bus, cost
3. Routes and Routing
4. Demography
5. Land Use
6. Trip Generation
7. Management
8. Financing Mass Transportation

Abstract: The report develops and evaluates alternatives for the initiation of publicly-owned transit services in Mountain View, California. The transit plan which emerged from this effort was designed to compliment county-wide and regional transportation systems.

The report describes three general factors which affect the planning of transit services. These include: (1) demographic characteristics, (2) land use development, and (3) travel patterns. An analysis of these variables indicated that although Mountain View is a sub-urban community of moderate density and high automobile ownership, a considerable demand for transit exists. An estimated one-third of all residents lack access to automobiles. On the other hand, the authors note that only about one-half of all area transit trips had origins and destinations located within the study area; other travelers will have to be interfaced with adjoining transit systems.

Alternative transit plans are described in detail with reference to existing service; routing concepts (ie. grids, loops, through routing, or flexible systems); operating schedules; coordination with neighboring communities; stations, stops, and shelters; bus equipment; and fares. The project generated two specific alternatives for further consideration; these differ principally in terms of route coverage and cost.

Patronage, revenue, cost, and financing data are reviewed in detail. Other economic considerations such as financial assistance and the social benefits of transit to the community are also examined. The report concludes with an analysis of transit management alternatives under the proposed public ownership plan.

NTIS Order #: PB-197-988
PC \$3.00, MF 95¢

Title: "Comprehensive Planning Organization Transit Survey: San Diego County, California"

Author: Comprehensive Planning Organization, County of San Diego

Date: March, 1970

Proj. #: CAL-T9-8

Keywords: 1. Ridership, profiles
2. Survey
3. Demography

Abstract: The purpose of this study was to collect and analyze basic data related to public bus transit systems within San Diego County. This research will provide information essential for developing an improvement program for the San Diego Transit Corporation, the largest bus system in the County. This program, which is in the preliminary stages, has the dual aim of producing a plan for the immediate improvement of service and a ten-year development program.

Public transportation for San Diego County is provided by bus companies and the Santa Fe Railway. The rail system was excluded from the study because of its low intra-county passenger volume. The public, scheduled bus companies to be considered are: (1) the San Diego Transit Corporation, purchased from a private firm in 1967 and now operated by the City of San Diego; (2) the Oceanside Transportation System, owned and operated by the City of Oceanside; (3) the Western Greyhound Lines, a division of the national corporation; and (4) San Diego Economy Line, Inc., a small and locally owned company.

Data on transit users were obtained through an extensive survey involving the distribution and collection of questionnaires on operating buses. Over 50,000 questionnaires in English and Spanish were distributed. The raw data were then processed by computer. The objective of this portion of the study was to learn more about the socio-economic characteristics of bus riders and their trip patterns. The survey results indicated that about one-half of San Diego and Oceanside riders were under 25 years of age. More women than men use public transit. About two-thirds of the users of the San Diego and Oceanside systems are women. The income of transit riders is generally low. Over 60% of San Diego, 63% of Oceanside, and 74% of Greyhound riders have annual incomes of under \$6,000. Transit riders are less likely to own automobiles than the general population. For example, only 57% of San Diego Transit riders belong to families owning an automobile versus 78% for the general San Diego population. Automobile ownership for Oceanside riders is 65%; for Greyhound riders, 49%.

Transit riders do not usually have the option of using an automobile instead of public transit. Over 85% of San Diego, 88% of Oceanside, and 75% of Greyhound riders did not have an automobile available for their trip. They can therefore be considered captives of the transit service. Each bus transit system has a specific geographical area which generates a large proportion of the trips made. Over one-third of all San Diego trips are generated by the downtown San Diego area. About two-thirds of all Oceanside trips are made to and from Camp Pendleton. Almost 60% of all Greyhound trips begin or end at the Port of Entry near Tijuana.

From 1948 to 1965 the number of revenue passengers in San Diego declined from about 61 million to less than 13.5 annually. In 1966 this trend reversed, and revenue passengers have since increased to about 16 million per year. In Oceanside the general trend has been upward, with some year-to-year fluctuations; riders have increased from about 1.6 million in 1960 to over 2.5 million annually.

NTIS Order #: PB-192-190
PC \$3.00, MF 95¢

Index No. 2-CAL-8.1

Title: "Transit Development Plan and Program"

Author: Alan M. Voorhees & Associates (for San Diego Transit Corporation)

Date: June, 1970

Project No. CAL-T9-8

Keywords: 1. Bus, rapid transit
2. Bus, express
3. Bus, transfers
4. Bus, priorities
5. Bus, cost
6. Management, operations and techniques
7. Government, urban
8. Schedules and Scheduling

Abstract: The report summarizes a comprehensive technical study of mass transportation in the San Diego metropolitan area. Service is currently provided by the public San Diego Transit Corporation and several smaller private bus lines. Although no major service problems were evident, interline transfers are not available and there is little areawide coordination among the systems. Management alternatives were reviewed, and creation of a metropolitan transit authority was deemed optimal. Household surveys to determine trip purposes, car availability, and transfer demand yielded a regional model for estimating ridership. The model was employed to develop two alternative future transit networks for San Diego.

The authors recommend a ten-year capital improvement program in conjunction with innovative service development projects. Possible techniques for attracting patronage include freeway express bus service, employer tax incentives, bus priorities at intersections, exclusive bus lanes, comprehensive information systems, and special consumer services. The authors also recommend several potential demonstration project candidates with reference to computer scheduling of buses, freeway corridor bus operations, shuttle service between the Model Cities area and a hospital, the new-technology bus vehicle, and a fleet-vehicle command and control system. The report concludes with a discussion of system priorities and costs.

NTIS Order #: PB-192-715
PC \$3.00, MF 95¢

Title: "Transit Access to Oakland International Airport" [Oversize Document]

Author: Kaiser Engineers

Date: October, 1970

Proj. #: CAL-T9-9

Keywords: 1. Airport, access
2. Urban Development, planning
3. Rail, systems planning and design
4. Routes and Routing
5. Bay Area Rapid Transit
6. Corridors

Abstract: The report is a comprehensive technical study of transit feasibility in the corridor between a proposed Bay Area Rapid Transit (BART) station and the Oakland International Airport. The Oakland-Alameda County Coliseum Complex, a major industrial park, and a secondary regional airport all lie within the study corridor. The authors note substantial growth potential throughout the area, provided that adequate transportation access is provided. Existing transportation facilities consist of heavily congested roads and freeways and a limited public bus system.

A review of potential transit service concepts revealed two alternatives for the corridor. These include: (1) extending the present BART system, and (2) installing a separate connector system through the study area. In addition, four vehicle concepts were considered, including: (1) the standard BART vehicle; (2) a modified BART vehicle; (3) a smaller, automated guideway vehicle; and (4) a conventional motor bus. Only the first design alternative could be used with the BART extension proposal; any of the other three could be employed in a separate connector system. The authors conducted a detailed transit impact analysis to determine four routing options, each designed to serve a different objective. One route would serve existing commercial and industrial development centers while another would serve the areas where future development is anticipated. A third route would serve the airport exclusively by providing nonstop service. The fourth route, with two branches, could serve all existing and future activity centers.

Various combinations of service concepts, vehicle designs, and routes were evaluated to yield an optimal configuration for the corridor. The connector alternative was found to provide more frequent and lower cost service than the BART extension. Although the small vehicle system indicated promising cost, capacity, and flexibility characteristics, the use of modified BART vehicles in the connector system was deemed necessary to make the system compatible with the BART mainline. The feasibility study also determined that a routing network designed to serve future industrial and airport developments would be optimal.

The report describes features of the proposed connector system in detail. Guideway and vehicle configurations will be similar to those of the larger BART system. The total connector route will span approximately 3.8 miles. An in-depth feasibility analysis concluded that operation of the connector system could prove economically beneficial both in terms of farebox revenues and the relief of regional traffic congestion. Additional engineering studies are recommended. The report concludes with a brief implementation plan. Appended material includes urban design criteria, results of a regional transit survey, a historical review of present airport transit links, methodology for patronage forecasting, criteria for development of the connector system, and interim program ridership data.

NTIS Order #: PB-197-837
PC \$3.00, MF 95¢

Title: "High Speed Ground Transportation Airport Access Route Study, Los Angeles International Airport to San Fernando Valley" [Oversize Document]

Author: Kaiser Engineers

Date: September, 1970

Project No. CAL-T9-10

Keywords: 1. Air Cushion Vehicle
2. Routes and Routing
3. Rail, systems planning and design
4. Rail, stations and terminals
5. Guideways
6. Speed and Speed Control
7. Power Distribution
8. Topography
9. Construction, materials
10. Airport, Access
11. Propulsion Systems, linear induction motor

Abstract: The report is a comprehensive route analysis of the proposed high speed ground transportation system to connect Los Angeles International Airport and the San Fernando Valley. The system will employ tracked air cushion vehicles (TACV) powered by linear induction motors in a demonstration of the concept for high speed urban transportation. The report is principally concerned with the proposed route profile; approximately 75% of the grade-separated TACV guideway structure will be located adjacent to the San Diego Freeway. The authors note that although small radii curves along the freeway alignment will limit overall TACV velocities, the design speed of 150 mph. will be attainable in two sections.

The proposed TACV will operate over a grade-separated, double U-shaped guideway with span lengths of 100 feet. The structural system is described in detail; concrete will be the primary construction material. Three proposed stations along the initial 16.4 mile route are also described. These will be located at the endpoints (ie. Los Angeles International Airport and the Sepulveda Dam Basin) and at an intermediate point well-served by freeway access.

Several alternating-current and direct-current electrification options were reviewed to determine the optimal system for TACV propulsion. A 1,500 volt DC system was selected primarily for its economic advantages; substation and power distribution requirements are outlined in the report. Vehicle performance is also discussed briefly with reference to running time and average velocities. Speeds of between 100 and 150 mph. should be achieved for a distance of approximately 46,000 feet. Finally, the authors note construction effects on freeway movement and determine that no foreseeable safety problems would be created by the project. Economic feasibility of the system will be considered separately in a later report.

Specifications for all basic system components are outlined. In addition, the report contains a route analysis which indicates gradients and location for each segment of the proposed system. Preliminary design criteria are also developed.

NTIS Order #: PB-197-953
PC \$3.00, MF 95¢

Title: "Evaluation of High Speed Ground Access Between Los Angeles International Airport and the San Fernando Valley"

Author: Systems Analysis and Research Corporation

Date: November, 1970

Project No. CAL-T9-10

Keywords: 1. Airport, access 4. Fare, cost determination
 2. Ridership, volume 5. Surveys
 3. Rail, cost

Abstract: The report evaluates a proposed high-speed ground access link between Los Angeles International Airport and the San Fernando Valley in southern California. The research was conducted under Phase II of the overall program, and it contains analyses of economic, financial, and marketing aspects of the system in operation. The system will consist of more than 24 miles of tracked air cushion vehicle guideway with two intermediate stations planned to serve major highway access and passenger interface points.

The report begins with a brief discussion of the need for improved airport access in Los Angeles. General problems, present and future freeway capacities, alternative systems, and airport parking limitations are summarized.

The analysis of projected system ridership constituted a major element of the Phase II evaluation. Airline passenger surveys were conducted to estimate potential ridership in the access corridor, air travelers at the airport in 1977, passenger peaking patterns, and overall system demand. The report concludes that the system will serve eight million passengers in the year 1977, 90% of whom will be air travelers. The development of an intercontinental airport facility at Palmdale was judged compatible with the Los Angeles airport access system. Other ridership data are summarized in the report along with survey procedures and selected tabulations.

A financial analysis was conducted with reference to passenger revenue, capital costs, operating expenses, financing capability, and projected financial results during the first five years of operation. The report forecasts yearly increases in revenues; by 1978, the system is expected to reach a profitable level of service.

The report also examines the sensitivity of demand and financial estimates to changes in various assumptions and parameters of the analysis. Such critical factors as fares, operating expenses, capital costs, passenger demand, load factors, and interest rates are discussed. The authors conclude that no major problems are anticipated, although the application of new hardware systems reduces the reliability of specific estimates. The passenger survey revealed, however, that most passengers were willing to absorb relatively high costs for fast and convenient service. Ninety-three percent indicated that they would pay one-way fares of \$2.00; 67% found a one-way fare of \$5.00 acceptable.

Some possible constraints to the system are reviewed, including baggage check-in procedures, terminal interfaces, system reliability, and the development schedule. The authors underscore the importance of reliability and convenience as the features most important to potential users, as indicated by the surveys. Additional survey data are appended.

NTIS Order #: PB-197-962
PC \$3.00, MF 95¢

Title: "Livermore-Amador Valley Transportation Needs Study"

Author: DeLeuw, Cather & Company

Date: October, 1971

Proj. #: CAL-T9-11

Keywords:	1. Bus, intercity	7. Benefit-Cost Analysis
	2. Bus, express	8. Social Benefits and Costs
	3. Bus, commuter	9. Urban Development, planning
	4. Demography	10. Routes and Routing
	5. Ridership, attraction	11. Bay Area Rapid Transit
	6. Small Cities	12. Financing Mass Transportation, sources

Abstract: The report is a summary of data, analysis, and recommendations generated by a comprehensive technical study of mass transportation for the Livermore-Amador Valley in northern California. The authors note that the study area has manifested rapid growth and development in recent years, and that proposed construction of the BART (Bay Area Rapid Transit) system may benefit from a supportive mass transportation system in the community.

Planning data are discussed in detail with reference to existing land use; demographic characteristics (ie. age composition, income levels, automobile ownership, and driver licensing); employment and labor conditions; travel patterns; special transit needs (of the elderly, youth, and low-income families); and to existing transportation service. The latter includes intercity bus service, a small-scale local carrier, school buses, and a taxi service. The authors conclude that analysis of these data supports the implementation of bus transit between the valley communities and the San Francisco-Oakland area (approximately 40 miles away). In addition, the authors recommend provision of intra-valley bus service, especially to connect the communities with a proposed East Bay BART link. The report notes that intra-community trip characteristics did not recommend bus transit as a viable alternative to trips currently made by private automobile.

Initial transit alternatives were analyzed to yield an optimal system. Conventional bus service options are discussed with reference to four alternate combinations of local, freeway, and suburban express networks. In addition, four non-conventional service alternatives were analyzed, including: (1) taxi, (2) Maxi-Taxi or Dial-A-Bus, (3) modified Dial-A-Bus, and (4) subscription bus service. The authors conclude that an inter-community bus express would be feasible, although no proposed routing was found likely to generate even one-half the revenues necessary to offset cost estimates.

The alternative transit proposals were subjected to an intensive benefit-cost analysis to yield an overall evaluation of transit potential in the Livermore-Amador Valley. Advantages of both express and local service were computed in terms of direct user benefits and indirect social and environmental benefits. The authors conclude that their analysis revealed little incentive to implement a local service, but that probable benefits from express service outweighed the costs. In addition, the data recommended use of flexible routing wherever possible to maximize user appeal and convenience.

The recommended transit plan is described with reference to express service (covering routes, headways, fares, equipment, management, and such ancillary facilities as parking), local routing, subscription buses, and the potential for future expansion. Cost factors are also outlined in detail. Implementation is examined with reference to financial alternatives (eg. participation in Federal grant programs, local taxation, and funds earmarked for development of BART), organizational options, and management.

NTIS Order #: PB-204-470
PC \$3.00, MF 95¢

Index No. 2-CAL-11.1

Title: "Tri-City Transportation Needs Study -- Summary & Conclusions Re: Alternative Plans; Interpretation of Household Survey; and Tri-City-Hayward Service Coordination"

Author: DeLeuw, Cather & Company

Date: March, 1971

Project No. CAL-T9-11

Keywords: 1. Community Response
2. Surveys
3. Social Benefits and Costs
4. Demand-Responsive Systems,
Dial-A-Ride
5. Benefit-Cost Analysis
6. Routes and Routing
7. Bus, cost

Abstract: The report begins with an evaluation of alternative transit service plans for implementation in the Tri-City area. Four of the proposed systems employ conventional fixed-route, scheduled bus service; the fifth would employ a mix of conventional routes and demand-responsive Dial-A-Bus service. For each alternative plan, various frequencies of service were also evaluated, giving a total of 16 alternatives. An economic analysis identified three plans with annual costs of less than \$1.5 million; these were carried forward for further evaluation.

The three selected plans emphasize coordination of bus transit with proposed stations of the Bay Area Rapid Transit (BART) system. A cost-benefit approach was employed for the secondary evaluation. The authors discuss the various components of both direct and indirect costs and benefits along with the results of a preliminary analysis of the "combination plan". The latter would include conventional and demand-responsive bus services, and it was found to generate benefits of some \$100,000.

The results of a public attitudes survey are also examined. The survey had two essential functions: (1) to identify community attitudes concerning the need for public transportation in the Tri-Cities, and (2) to determine how respondents evaluate specific public transportation alternatives. Four key findings of this research include: (1) A vast majority of all respondents felt that public transportation is needed in the cities of Fremont, Newark, and Union City. (2) Transportation for persons with limited mobility was the primary objective cited most frequently. (3) Two-thirds of all respondents expressed a preference for the larger alternative system. (4) Hourly service and 25¢ fares were preferred.

NTIS Order #: PB-210-323
PC \$3.00, MF 95¢

Title: "Denver Transit Study"

Author: W.C. Gilman & Company, Inc.

Date: October, 1970

Project No. COLO-T9-4

Keywords: 1. Management
2. Construction, contracts
3. Quantitative Analysis
4. Qualitative Analysis
5. Quality Control

Abstract: The report studies current and short-range (to 1975) public transit needs in the Denver metropolitan area. The nine-phase project sought to develop methods to fulfill the objectives of Denver's 1985 comprehensive plan.

Phase 1 consisted of refining the work program, defining responsibilities and time schedules, establishing operating criteria, and coordinating services to be provided during the study project. Relevant data were collected in Phase 2 for analysis in subsequent work phases. The principal areas of data collection were: (1) historical and current operating data for the Denver Tramway Corporation; (2) an inventory of tangible assets; (3) existing and forecasted demographic, land use, socioeconomic, and travel pattern data available from local organizations; (4) origin and destination survey data; and (5) other relevant statistical material.

Phase 3 consisted of determining the value of the tangible assets of the Denver Tramway Corporation. Based upon data collected through the physical inspection and inventory of tangible assets in Phase 2, a "current service value" was determined. An actuarial firm was also engaged to determine the pension liability of the transit company. Concurrent with the valuation activity, alternate forms of ownership and management were investigated and evaluated, and appropriate recommendations were fashioned.

Phase 4 was devoted to surveying wages and working conditions of comparable transit properties in the geographical area. In Phase 5, relevant data assembled in Phase 2 were analyzed to provide a basis for subsequent recommendations; in view of the urgency of the study, time-consuming analytical techniques were avoided and major reliance was placed on the experience of the consultant. In Phase 6, a short-range (five year) transit improvement program was recommended. Advance statements of the results of operation under a range of fare structures were projected in Phase 7 for a five-year period. In Phase 8, the staging program for the transition from the existing to the recommended system was defined; the staging plan includes priorities, capital requirements, sources of capital funds, and a detailed schedule of critical events. The final report of the study results and recommendations was prepared in Phase 9.

NTIS Order #: PB-199-369
PC \$3.00, MF 95¢

Title: "Proposed Transportation Master Plan for Dade County -- A Summary"

Author: Metropolitan Dade County Planning Department

Date: February, 1969

Proj. #: FLA-T9-1

Keywords: 1. Urban Development, planning
2. Financing Mass Transportation
3. Highway, planning
4. Rail, systems planning and design
5. Routes and Routing
6. Bus, busways
7. Bus, express
8. Airport, planning and operations
9. Aircraft, traffic control

Abstract: The report outlines a comprehensive transportation master plan for the Miami metropolitan area. The year 1985 was a selected target date for completion of an estimated \$1.5 billion program to be financed by local taxes, other conventional sources of urban revenues, and participation in relevant Federal assistance programs. The report summarizes recommended transportation improvements broken down by mode.

Proposed street and highway developments include nine new expressways, eight express streets, and improvements on all major arterials. A total of some 375 miles of new construction is recommended along corridors identified by extensive demographic analysis and travel patterns forecasting. Specific planning data, however, are not reproduced. In addition to the new highways, the report suggests re-surfacing and widening of existing roadways throughout the urban network.

Recommendations for public transit improvement include 24 miles of rapid transit, 22 miles of elevated busways, and 43 new surface bus routes to handle an estimated 100% increase in transit ridership before 1985. Specific corridors to be served were also identified by projections of area demography and trip generation. In addition, the authors recommend vehicle design criteria, routes, special service for airport access, and continued investigation of dual-mode buses and other innovative transit systems.

Airline passenger volumes are expected to increase by nearly 500% before the target year. As a result, the report focuses special attention on airport development throughout the Miami metropolitan area. Of particular concern is the possible availability of the Homestead Air Force Base for use by commercial operators. The authors also recommend investigation of a possible airport site in the Florida Everglades, assuming that potential environmental problems can be overcome. The report proposes integration of all private and commercial aircraft control operations, use of a satellite terminal for passenger check-in in Miami Beach, and construction of three new general aviation facilities.

The report also provides brief recommendations for seaports and waterways and for multi-modal terminal facilities. Specific proposals include construction of a new seaport complex and ship canal with related access facilities. Terminal and station requirements for truck, rail, bus, automobile, and air modes are also discussed.

Appended material highlights data from earlier planning studies conducted in the Dade County area along with detailed cost and revenue forecasts for implementation of the transportation master plan.

NTIS Order #: PB-184-764
PC \$6.00, MF 95¢

Title: "Terminal Facilities Master Plan"

Author: Metropolitan Dade County Planning Department

Date: December, 1968

Proj. #: FLA-T9-1

Keywords: 1. Freight Movement 7. Parking, facilities
2. Bus, intercity 8. Parking, planning
3. Bus, stations and shelters 9. Urban Development, planning
4. Rail, stations and terminals 10. Safety
5. Trucks and Truck Lines 11. Site Selection
6. Land Use

Abstract: The report examines existing multi-modal terminal facilities in the Miami, Florida, metropolitan area, projects future requirements, develops criteria for expansion, and synthesizes specific recommendations for terminal development planning. The analysis comprises one aspect in preparation of an overall regional transit plan for 1985. The authors focus upon four specific transportation modes to evaluate terminal facilities. These include: (1) trucks, (2) railroads, (3) intercity buses, and (4) automobiles [ie. parking].

An initial objective of the report was to fashion basic criteria for long-range terminal development. Four such guidelines are advanced: (1) Terminals should enhance the general urban environment; (2) Terminals should maximize accessibility to reduce travel time; (3) Terminal design should promote operational efficiency; and (4) Terminal design and location should emphasize safety and decrease vehicular accident rates. In addition, the authors suggest several basic design standards with reference to site selection, user amenities, integration within the existing urban area, and noise and air pollution.

The authors also develop a framework for implementation which will accommodate technological and regulatory changes in the operations served by urban transit terminals. These are advanced with particular reference to trucking, and include such innovations as piggybacking and automated management systems.

The report also contains a comprehensive inventory of existing terminal facilities and operations, broken down by mode. In addition, the authors project future demands for terminal handling of cargo, passengers, and parking. All relevant data are provided in detail; estimates of future requirements were developed principally on the basis of projected increases in population and land usage.

Several specific long-range recommendations are advanced for each mode. The authors forecast the need for a 54% increase in terminal space for trucks and other non-rail freight movement. Seven specific locations for new terminal construction are identified along with requisite zoning ordinances and suggested special truck routes through the center city. The authors found existing railroad facilities adequate, although such service improvements as the operation of high-speed trains and modification freight tariffs are recommended. Intercity bus ridership is expected to increase by 75% before 1985, and the report recommends construction of a wholly new terminal facility to be shared by both carriers now serving Miami. Finally, the authors project a need for some 68,000 additional parking spaces. An implementation schedule and continuing programs of transit study are discussed briefly.

NTIS Order #: PB-184-729
PC \$6.00, MF 95¢

Title: "Transit Routes 1985: Interim Report #4"

Author: Simpson & Curtin, Transportation Engineers (for Metropolitan Dade County Department of Traffic and Transportation)

Date: February, 1971

Proj. #: FLA-T9-1

Keywords: 1. Routes and Routing
2. Trip Generation
3. Modal Split
4. Demography
5. Ridership
6. Bus, Feeder
7. Access, Planning and Control
8. Urban Development, Planning
9. Algorithms
10. Rail, System Planning and Design
11. Rail, Stations and Terminals

Abstract: The report is an analysis of rapid transit alternatives for implementation in the Miami, Florida, Metropolitan Area by 1985. Specifically, the report refines and expands upon a system proposed by the Miami Urban Area Transportation Study (MUATS), utilizing ridership data, forecasting techniques, and an analytical methodology outlined in other reports generated by FLA-T9-1. The purpose of this report was to develop an optimum mass transit system for Miami by examining four "test networks" each of which represents a progressive refinement of the proposed system.

The authors begin with a brief discussion of the steps used in their transportation planning process. The planning factors employed included: inventory, forecast, trip generation, trip distribution, modal split, and assignment. An overall planning algorithm is outlined from which emerges an evaluation methodology. The report also focuses on projections for Dade County in 1985, particularly the estimated growth of seven key indicators, and on travel patterns in the area.

The authors note that the MUATS proposal was intended primarily to demonstrate the need for rapid transit rather than to recommend a specific route. The report attempts to construct an optimal system by testing refinements of the MUATS plan with methods developed earlier. The four networks were not drawn simultaneously, but were the results of successive iterations, each being devised after testing the preceding one. The networks were evaluated according to a wide variety of performance and service criteria. The routes were compared in terms of both overall characteristics and segment-by-segment analysis.

The authors conclude with a specific recommended rapid transit system and supporting bus network. The proposal is outlined in detail in both general terms and in service segments to different areas of Miami. The report emphasizes the need for coordination between bus and rapid transit in feeder operations and to provide comprehensive public transportation throughout the urban area. The report also estimates 1985 average daily traffic at each proposed station and between stations. Two appendices outline access modes to rapid transit stations and the surface bus system. The former includes a complete projected statistical breakdown of modal split in access to the rapid transit; the latter recommends specific bus routes to supplement the rapid transit.

NTIS Order #: PB-210-313
PC \$3.00, MF 95¢

Title: "Public Transportation in Metropolitan Pensacola, Florida"

Author: Coverdale & Colpitts, Consulting Engineers

Date: May 16, 1969

Proj. #: FLA-T9-3

Keywords: 1. Public Ownership
2. Government, Urban
3. Government, Taxation
4. Ridership, profiles
5. Financing Mass Transportation, requirements

6. Advertising and Promotion
7. Bus, Intracity
8. Bus, Cost
9. Demography
10. Modal Split
11. Trip Generation

Abstract: The report is a comprehensive summary of transit operations and ridership in the Pensacola metropolitan area with reference to improved service and greater economy. In an overview, the authors discuss the continuing need for mass transportation, but note that private operation of the local bus company is no longer economically feasible. Three basic criteria are advanced for revitalizing transit as a public service, including: (1) acquisition of new, air-conditioned coaches; (2) modification of existing routes and schedules to meet passenger demands and provision of special services; and (3) vigorous promotional campaigns to stimulate ridership. As a fourth criterion, the authors recommend public ownership and operation of the transit system, accompanied by subsidies to augment declining farebox revenues.

The report examines the current transit system in reference to history; organization; general operations; service outputs such as express, charter, and school buses; and an inventory of property and equipment. A financial analysis is also included assessing capital stock and outstanding liabilities. Various demand-related and demographic aspects of the current operation are also examined including: population and economic data, modal split, trip generation, and other travel characteristics. The authors conclude from the latter that work trips feature primarily in local transit usage and that the overall route pattern is generally responsive to patronage demands.

The ownership and management of mass transportation by the public agency is examined in detail. The report delineates specific requirements for management, capital replenishment, and subsidies based on overall cost estimates. The authors recommend the creation of an area-wide or regional transportation authority supported by a continuing source of revenue adequate to both operate and to expand and modernize present transit services. A variety of potential sources of funding are explored; the authors note particularly the feasibility of general tax revenues based on experience elsewhere.

NTIS Order #: PB-191-133
PC \$3.00, MF 95¢

Title: "Mass Transit in the Tampa Bay Region -- Summary Report"

Author: Tampa Bay Regional Planning Council

Date: UNDATED

Project No. FLA-T9-4

Keywords: 1. Urban Development, planning
2. Bus, intercity
3. Rail, systems planning and design
4. People Mover
5. Financing Mass Transportation

Abstract: The report summarizes highlights of a comprehensive transit plan for the Tampa Bay metropolitan area. Current operations are examined briefly. The region is served by five individual bus companies, four of which are privately owned. The report notes that existing services are poorly coordinated and that a substantial proportion of the rolling stock is deteriorated. In addition, ridership on all lines has declined steadily over the past two decades. Current operations emphasize service only for "transit captives" who lack access to a private automobile. As a result, intra-regional travel patterns are dominated by the private mode.

Four basic objectives were developed to guide the transportation planning process. These include: (1) expanded and improved service for all segments of the population; (2) balanced regional transportation to satisfy the variety of travel demands; (3) efficient and dependable service that can accommodate future transit requirements; and (4) opportunities to integrate new technologies as they become available. These basic goals were employed to develop a recommended short-range transit improvement program. The immediate proposals were designed to upgrade existing service, replace deteriorated capital stock, and renovate public transit facilities. A \$7.2 million plan is advanced to meet these objectives by 1975. In addition, the report recommends creation of a Regional Transit Coordination Committee and major changes in current routes and schedules.

The authors also identified several high-demand travel corridors in which a regional rapid transit system might be located. The proposed network would cover some 54 miles through high-density areas; additional segments of an equal length are also proposed for future consideration. The report examines five potential rapid transit concepts which could be applied to the Tampa Bay area. These include: (1) monorail, (2) mini-systems [ie. dual-mode cars and personal rapid transit], (3) air cushion vehicles, (4) conventional rail rapid transit, and (5) rubber tire-on-guideway systems. Each concept is described briefly; the authors do not attempt to recommend adoption of any specific design for the proposed transit network.

Three long-range planning objectives are advanced with reference to: (1) establishment of a three-level system of regional transit service [ie. intra-city, intra-regional, and inter-regional]; (2) establishment of a Regional Transit Service Corporation to guide all future transportation development in the metropolitan area; and (3) receipt of sufficient state and Federal assistance to finance the proposed improvements.

NTIS Order #: PB-192-404
PC \$3.00, MF 95¢

Index No. 2-FLA-4.1

Title: "Tampa Bay Mass Transit: Planning for Tomorrow"

Author: TRW Systems, Inc.

Date: April, 1970

Proj. #: FLA-T9-4

Keywords: 1. Ridership, volume
2. Parking, capacity and demand
3. Traffic, congestion

Abstract: This report presents the results of a study designed to examine the potential for future transit systems in the Tampa Bay Region and to construct a Mass Transit Study Plan to evaluate, select, and implement a new Tampa Bay Region transit system. The Transit Potential Study concentrated its analysis on: examination of forecasts of development parameters which affect transit ridership; calculation of future parking requirements in the more densely settled areas using results from the Tampa Bay Region Major Highway Study; matching development and traffic forecasts against criteria for rail transit systems; and manipulating a simplified Rapid Transit Model to determine the necessary conditions for implementing a successful regional rapid transit system in the 1980's.

Bus service in the Tampa Bay Region has suffered a general decline in patronage as a result of increasing operating costs and a limited service area. The transit system's equipment is old and fails to meet the minimum standards of comfort desired by transit patrons. Pinellas County has four municipal transit systems. Three of the systems, St. Petersburg Municipal Transit System, Pinellas Park Transit System, and Gulf Beach Transit System, operate on lines originating from the central business district of St. Petersburg. The fourth system, Clearwater Municipal Transit System, originates service from the Clearwater central business district. Hillsborough County is served by Tampa Transit Lines, which serves most areas of the county with a population density greater than 3.00 people per acre. No service is provided to other major urban areas of the Region. Manatee and Sarasota Counties are served jointly by one municipal bus transit system, Cities Transit, Inc., which operates from a terminal located in the City of Sarasota.

The authors concluded that it was not likely that local bus service in the Tampa Bay Region will show substantial improvement in the future without financial and planning assistance and/or important changes in the development patterns of the Region. However, there is a substantial potential transit ridership in the Region. A very small percental of the total trips are transit trips, yet it is certain that one-fifth to one-quarter of the citizens of the Region either have no access or very limited access to an automobile. It is the authors' opinion that future automobile traffic problems, such as highway congestion and lack of parking space, can be avoided with an extensive road-building program and enactment of parking supply legislation (such as requiring builders of new office buildings in densely settled locations to provide minimum levels of multi-story parking).

NTIS Order #: PB-192-405
PC \$3.00, MF 95¢

Title: "Mass Transit Concepts for the Tampa Bay Region: Inventory, Analysis, Objectives and Improvement Program"

Author: Tampa Bay Regional Planning Council

Date: April, 1970

Proj. #: FLA-T9-4

Keywords: 1. Bus, intracity 5. Government, intergovernmental relations
2. Bus, cost 6. People Mover, monorail
3. Financing Mass Transportation 7. Public Ownership
4. Ridership 8. Routes and Routing

Abstract: The report is a comprehensive technical study of mass transportation alternatives for the Tampa Bay area in Florida. The authors note that land in the central city devoted to handling automobile transportation may grow to include as much as 70% in certain areas, and that a detailed plan for developing public transit systems is therefore warranted.

The report begins with an inventory and analysis of existing transit services which include five local bus companies, intercity service, and an airport limousine. The authors note that a substantial amount of operational rolling stock is badly deteriorated and outmoded; all but one of the transit companies is under private ownership. A detailed analysis of patronage and demand revealed a characteristic profile of declining ridership and soaring costs which cannot be met through farebox revenues. Passengers were generally "captive" riders who lacked access to an automobile (ie. the poor, elderly, non-driver, and non-white population groups). The authors note a relatively poor match between potential demand and existing routes which is frustrated somewhat by the limited jurisdiction of each company in the Bay Area. The report concludes that a three-level transit system is necessary which will provide intracity, intra-regional, and inter-regional services.

Five alternative mass transit concepts were evaluated for possible implementation. These included rapid rail, rubber tire-on-guideway vehicle, monorail, and air cushioned systems. Each system was ranked according to eight operational variables to yield an optimal concept for the Tampa Bay area. It was concluded that the monorail or rubber tired systems were best suited for further development. Each concept is described briefly; the authors do not attempt, however, to recommend immediate construction of any specific system in their near-term improvements program.

Two primary objectives were fashioned to guide future transportation planning in the area. These include: (1) establishment of a Regional Transit Service Corporation [RTSC] to control development of mass transportation in the Tampa Bay communities; and (2) participation in relevant federal and state financial assistance programs. Additional objectives embracing service requirements, system flexibility, balanced mass transportation, and demand-responsive routing are also advanced.

The report concludes with a short-range bus transit improvement program designed to make the existing systems more attractive and to update rolling stock and related facilities. A total expenditure of some \$7.2 million over five years is projected. The improvement program would also stress coordination of presently fragmented transit managements through the public RTSC.

NTIS Order #: PB-192-409
PC \$3.00, MF 95¢

Title: "The Atlanta Plan: Rapid Transit for the People"

Author: Henry L. Stuart (Metropolitan Atlanta Rapid Transit Authority)

Date: July, 1970

Project No. GA-T9-1

Keywords: 1. Rail, systems planning and design 5. Surveys
2. Rail, cost 6. Financing Mass Transportation
3. Advertising and Promotion 7. Government, urban
4. Community Response 8. People Movers

Abstract: The report is an overview of activities conducted by the Metropolitan Atlanta Rapid Transit Authority (MARTA), with particular attention given to its regional transit plan. Introductory material reviews the history of rapid transit planning in Atlanta, activities sponsored by the Federal technical studies grant, other activities of MARTA, and a review of the 1968 MARTA referendum which was defeated. Future plans of the Transit Authority are also discussed.

The report contains ten separate appendices which cover various aspects of the rapid transit plan. Appendix I outlines the preliminary system plan and contains detailed schematic illustrations of the proposed rail system configuration. Appendices II and III reproduce selected material from past issues of "Rapid Transit Progress," a publication of MARTA.

Appendix IV provides excerpts from a survey of area voters taken six months prior to the referendum defeat. The data indicated that a slight majority of respondents favored the proposal and that support generally correlated with age and income levels. Recommendations for the pre-election campaign are summarized. Appendix V outlines system features and a recommended schedule of development and construction for the proposed 40-miles of rapid transit.

Appendix VI contains excerpts from MARTA's 1968 financial plan with reference to overall costs and expenditures, issuance of bonds, amortization, debt service, and other factors. Appendix VII is the final draft of proposed contracts between MARTA and participating local governments, including a proposed trust indenture. Appendix VIII provides samples of various campaign materials used to promote the MARTA referendum.

Appendix IX is a collection of papers and exhibits that summarize the findings and proposals generated by a 14-month study of Atlanta's transportation needs. The research was undertaken by a private contractor and includes features of the proposed system, alternative system designs, an evaluation of highway alternatives, and a recommended program of action.

Appendix X is a comprehensive review of alternative vehicle systems. Specific concepts and applications are described for each of six generic vehicle categories, including: (1) duorail [ie. conventional rail systems], (2) monorail, (3) small-module systems, (4) air-cushioned systems, (5) tubeflight systems, and (6) other systems such as dual-mode buses and palletized transportation. Fact sheets with specifications for each system and an inventory of transportation concepts are appended.

NTIS Order #: PB- 197-259
PC \$3.00, MF 95¢

Title: "An Integrated Island-Wide Bus System -- Summary Report"

Author: Alan M. Voorhees & Associates, Inc.

Date: April, 1971

Proj. #: HAW-T9-2

Keywords:	1. Public Ownership	6. Surveys
	2. Routes and Routing	7. Government, urban
	3. Bus, intracity	8. Management, operations and techniques
	4. Ridership	9. Advertising and Promotion
	5. Trip Generation	10. Financing Mass Transportation, sources

Abstract: The report summarizes analysis and recommendations generated by a comprehensive technical study of the Honolulu, Hawaii, bus transit system. In a brief introductory section, the authors trace the history of mass transportation on the Island of Oahu and note that current trends reflect a common profile of declining ridership and rising costs which cannot be met by farebox revenues alone. Present service is provided by three competing transit companies; none of the systems generates sufficient demand volume to offset operating costs and equipment depreciation schedules. An overview of costs, earnings, and revenues is included along with an outline of major service deficiencies. The latter includes high load factors, low schedule reliability, lack of interservice transfers, routes which are unresponsive to projected demand, excessive travel times, outmoded rolling stock, and inadequate information services.

Existing ridership is detailed along with projections of future demand; the survey indicated that as many as 8,000 potential residential trip generators were unserved. Based on these data, the authors synthesized three levels of service reorganization (ranging from minimal to extensive) and two management approaches stressing unification or coordination of the competing systems. A cost analysis of these alternatives in various combinations is appended.

The authors recommend municipal acquisition of the transit operations throughout the island, and purchasing of capital equipment from present operators. In addition, the authors recommend an investigation of tax options to provide subsidy revenues in lieu of increased fares. Other specific recommendations with reference to routing, purchase of new rolling stock, and service improvements are advanced. The report suggests fourteen ancillary improvements designed to promote ridership demand by making bus use an attractive alternative to the private automobile. A recommended management and maintenance structure is outlined in detail.

A final section documents highlights of a 1970 passenger survey which is examined in greater detail in another report generated by HAW-T9-2. Among the significant findings advanced were: (1) Females outnumbered males two to one; students accounted for 50% of all demand. (2) Nearly 85% of all riders were "captives" who did not enjoy access to an automobile; 50% lacked drivers licenses entirely. (3) Work and school trips comprised the overwhelming majority of rides on public transit buses.

NTIS Order #: PB-204-402
PC \$3.00, MF 95¢

Title: "An Integrated Island-Wide Bus System -- Volume I: Analysis and Recommendations"
Author: Alan M. Voorhees & Associates, Inc. (for City and County of Honolulu)
Date: April, 1971 Proj. #: HAW-T9-2

Keywords: 1. Bus, intracity 7. Public Ownership
2. Financing Mass Transportation 8. Public Relations
3. Ridership, profiles 9. Fares, cost determination
4. Government, urban 10. Benefit-Cost Analysis
5. Management, operations and techniques 11. Surveys
6. Routes and Routing 12. Bus, transfers

Abstract: The report summarizes principal recommendations generated by a comprehensive technical study of bus transportation in Honolulu, Hawaii. The current transit network consists of three competing bus companies who suffer common profiles of declining ridership and rising costs which cannot be met through farebox revenues. The purpose of the report is to review and analyze alternative proposals for improving mass transportation in the area.

The report examines current service with reference to patronage trends, costs and revenue, operating and service deficiencies, and projected market demand. All relevant statistical data and survey methodology are described in detail. The authors synthesized three improvement packages incorporating alternative options for management, service improvement, equipment replacement, and financing. These were subjected to intensive benefit-cost analyses to yield a recommended program. The latter is described in detail with reference to five general areas in which improvements are expected to generate increased demand. The five areas include: (1) modifications to existing routes; (2) development of new routes; (3) service improvements [eg. acquisition of new rolling stock, renovation of passenger shelters and loading facilities, provision of park-and-ride services, etc.]; (4) promotional improvements, including restructuring of fares and increased public information services; and (5) other recommendations particularly with reference to legislation and management. Alternative administrative options are also reviewed in detail.

In their analysis of present service, the authors identified seven general deficiencies, including: unserved areas, poor responsiveness to demand, lack of interservice transfers, aged equipment and facilities, insufficient information systems, inefficient scheduling, and high load factors. The authors also determined that ridership consisted primarily of home-based work and school trips and that as many as 9,000 potential riders (constituting approximately 10% of the current daily volume) were not served by any existing route.

Three alternative improvement packages ranging from extensive to minimal were reviewed; the authors recommend adoption of a moderate option which includes public ownership and subsidies to cover operating deficits. Under this recommendation, the three rival companies would be bought out by the City of Honolulu which would retain current fares and provide subsidies financed with public revenues. Recommended system improvements are also advanced with reference to acquisition of new coaches, rerouting to better serve projected demand, institution of fare passes, revision of the fare structure, and implementation of other passenger amenities. The authors conclude that an optimal administrative system would be within a City Transportation Department, funded by general local tax revenues and maximum participation in relevant Federal grant programs.

NTIS Order #: PB-204-399
PC \$3.00, MF 95¢

Title: "An Integrated Island-Wide Bus System -- Volume II: The Transit Environment"

Author: Alan M. Voorhees & Associates, Inc. (for City and County of Honolulu)

Date: April, 1971

Project No. HAW-T9-2

Keywords: 1. Bus, intracity
2. Industrial and Labor Relations
3. Public Ownership
4. Financing Mass Transportation, sources
5. Government, urban
6. Government, county
7. Government, Federal
8. Government, taxation

Abstract: The report reviews several issues relevant to a recommended transit improvement program for the Honolulu, Hawaii, metropolitan area. The report focuses principally upon legal and financial implications of public acquisition and operation of services currently provided by three competing bus companies. The authors provide an initial overview of the present system with reference to the individual private operators, a statistical profile of the system, and current regulations enforced by the Public Utilities Commission and by pertinent legislation.

The report examines legal procedures by which the city could carry out its proposed acquisition of public bus transportation. Three alternative methods are outlined with reference to: (1) statutory public authority to condemn mass transit systems, (2) general powers of eminent domain, and (3) authority to terminate franchises granted to private transit operators.

The authors also discuss the application of various taxes to alternative proposals for administering bus transit in the urban environment. The authors conclude that savings from tax exemptions would be maximized under the recommended plan of city ownership and operation. Eight separate tax sources are examined in depth along with recommended public participation in relevant Federal grant programs. Federal standards set by recent legislation are also discussed with reference to their applicability to private operations and implicit labor standards.

Management and labor requirements generated by public acquisition are outlined. The report reviews Federal labor standards and existing state and local laws which would apply to contract agreements negotiated under a system of public ownership. Existing contract provisions are reviewed in detail along with an analysis of general collective bargaining practices in the mass transit industry.

Finally, the report covers methods for financing proposed subsidization of bus transit in Honolulu. Projected fiscal capacity at the city and county levels is discussed along with estimated borrowing potential. Public debt service provisions are outlined as well as the estimated potential for marketing revenue bonds.

NTIS Order #: PB-204-400
PC \$3.00, MF 95¢

Title: "An Integrated Island-Wide Bus System -- Volume III: 1970 Bus Passenger Survey"
Author: Alan M. Voorhees & Associates, Inc. (for City and County of Honolulu)
Date: April, 1971 Proj. #: HAW-T9-2

Keywords: 1. Surveys 5. Bus, commuter
2. Ridership, profiles 6. Computers, programming
3. Trip Generation 7. Sex
4. Routes and Routing

Abstract: The report is a detailed summary of survey methods and findings employed in a comprehensive technical study of bus ridership characteristics in Honolulu, Hawaii. Data collection methodology is detailed with reference to sample selection, preparation of the survey instruments, on-board polling, coding procedures, and computer processing. The report attempts to examine all relevant aspects of collecting data throughout a major urban transit system. The purpose of the study was to develop a comprehensive statistical base with which to synthesize a program of recommended transit improvements.

Findings are summarized in detail with reference to ridership profiles, trip generation, major corridors, modal split, time period distribution, demand potential on selected routes, and comparisons with earlier transportation studies in the area. The report concludes with a model for estimating the demand volume on potential routes. The author notes that a household survey revealed as many as 8,000 homes in the unserved transit market.

Several major findings were yielded by data analysis. First, it was found that females outnumber males in overall ridership two to one. Students constituted 50% of all passengers, although school trips accounted for only 25% of total demand. Second, the authors noted that up to 85% of all transit users were "captives" who did not enjoy access to a private automobile. Third, the study located several principal trip generators; the report concludes that demand is very unevenly distributed throughout the metropolitan area, thereby creating special requirements for demand-responsive routing. Finally, the authors concluded that ridership patterns had not changed substantially from those identified by an earlier study published in 1967. The only major difference recorded was a seven percent decline in home-based trip making.

The report contains comprehensive statistical data in tabular, graphic, and map forms. The authors do not advance any specific recommendations for reorganizing transit service, but rather, attempt to provide the information base with which such suggestions can be fashioned.

NTIS Order #: PB-204-401
PC \$3.00, MF 95¢

Title: "An Initial Chicago North Suburban Transit Improvement Program, 1971-1975 --
Volume I: Report and Exhibits"

Authors: Richard H. Pratt and Howard W. Bevis (for North Suburban Transportation
Council)

Date: May, 1971 Proj. #: ILL-T9-2

Keywords:	1. Bus, intracity	7. Suburbs
	2. Bus, intercity	8. Modal Split
	3. Bus, commuter	9. Parking, facilities
	4. Rail, commuter	10. Parking, planning
	5. Rail, stations and terminals	11. Ridership, volume
	6. Skokie Swift	12. Financing Mass Transportation, re- quirements

Abstract: The report summarizes results of a comprehensive technical study conducted in the suburban area north of Chicago, Illinois. The purpose of the report was to develop near-term planning data and to synthesize recommendations for improving the current mass transportation network. The authors begin with a detailed examination of the transit market, covering such topics as: existing data sources, population and development characteristics, travel patterns, ridership profiles, travel analysis by zone, modal split and travel quality forecasts, and other estimation techniques.

The report examines existing mass transportation systems in detail, broken down between rail and bus modes. The study area enjoys the services of two commuter railroads and two rapid transit lines which provide commuter links with the Chicago central business district. Rail service is discussed in detail along with such ancillary facilities as parking. The authors emphasize the importance of adequate parking to encourage greater diversion of automobile commuters to the rail mode. Existing facilities are evaluated, and specific recommendations for additional parking facilities are advanced. The report also focuses in depth on possible service improvements on the Skokie Swift, the area's major rapid transit system.

Existing bus service is also analyzed at length with reference to routes, schedules, fare structure, equipment and facilities, operating expenses, and projected ridership trends. The authors note the importance of developing a "suburban bus concept" within which several localized operations could be integrated to provide area-wide service under a single organizational structure. An evaluation of expanded suburban bus service is provided which forecasts potential ridership and impact on other modes.

The authors also note that mass transportation in a growing suburban area must be sensitive to changing patterns of land use and urban demography. The latter is discussed particularly with reference to area employment projections and the effect of residential development on system viability.

The report concludes with a detailed schedule of proposed service improvements. These include: (1) expansion of commuter parking facilities at rail stations; (2) construction of a new stop on the Skokie Swift rapid transit route; (3) possible participation in Federal grant programs to subsidize capital improvements for the Milwaukee Road commuter railroad; (4) widely expanded bus operations designed to ultimately increase ridership by 62% throughout the suburban area; and (5) coordination of all mass transit services and fares by a single agency. The report also includes a detailed implementation program covering such specific areas as financing, creation of a transit district, program staging, and immediate program task descriptions.

NTIS Order #: PB-204-873
PC \$3.00, MF 95¢

Title: "An Initial Chicago North Suburban Transit Improvement Program 1971 - 1975 --
Volume II: Technical Supplement"

Authors: Richard H. Pratt and Howard W. Bevis (for North Suburban Transp. Council)

Date: July, 1971

Proj. #: ILL-T9-2

Keywords: 1. Ridership, volume
2. Modal Split
3. Parking, facilities
4. Parking, capacity and demand
5. Skokie Swift
6. Rail, stations and terminals
7. Schedules and Scheduling
8. Employment
9. Land Use
10. Bus, commuter
11. Rail, commuter

Abstract: The report contains nine appendices to a comprehensive short-range transit improvement program for the north suburban area of metropolitan Chicago. The appended material includes basic statistical documentation and analyses from which the recommended plan was developed.

Appendix A is a user analyses supplement which examines area travel patterns and trip characteristics as revealed by a 1964 survey of suburban households. The data emphasize modal split broken down among several variables including age, destination, and trip generation. These statistics were used to develop travel forecasting models which are described in Appendix B. Derivation of modal split equations is outlined in detail. The authors note that "synthetic" ridership projections accurately replicated actual patronage on all public transit modes. Appendix C tabulates results of a comprehensive inventory of commuter parking facilities at all railroad and rapid transit stations. Data are provided with reference to type and location of the facilities, condition, typical walking distance to station, fees if any, capacity, occupancy rates, and competition for available spaces by non-commuters.

Appendix D contains analyses of seven proposed sites for construction of new rapid transit stations by the Skokie Swift (the area's major commuter transit line). Detailed maps of each location are supplemented by textual inventories of available space, traffic conditions, feeder bus potential, adjacent land usage, and probable competition from other public commuter modes. Appendix E outlines potential alternatives for improving bus transportation in the suburban area. Operational modes are discussed with reference to conventional service, reserved right-of-way, pulse scheduling, premium service, and demand-actuated operation. Service requirements for each option are outlined in detail. Appendix F provides additional bus analyses, broken down among usage forecasting, characteristics of short vs. long trips, the sensitivity of ridership to service frequency, and the probable effect of fare structure on patronage.

Appendix G attempted to estimate the impact of improved bus transit on area employment opportunities. Four specific conclusions are advanced: (1) The major influence on employment growth will continue to be accessibility via private automobiles; (2) The areas manifesting high demand for public transit are also those with the least available land for non-residential uses; (3) The areas where substantial non-residential land usage is available are those least able to generate sufficient patronage to support a bus operation; and (4) The authors conclude, however, that even the minor reduction in area unemployment that would follow improved bus service would constitute a considerable socio-economic benefit. Appendix H outlines operating statistics for each transit line currently servicing the suburban area with reference to total ridership and revenues. A final section cites the reactions of area transit operators to establishment of the North Suburban Transportation Council and to its recommended transit improvement plan.

NTIS Order #: PB-204-874
PC \$3.00, MF 95¢

Title: "Prototype Suburban Transportation Centers"

Author: Northeastern Illinois Planning Commission

Date: March, 1971

Proj. #: ILL-T9-2

Keywords: 1. Interfaces 6. Pedestrians
2. Rail, stations and terminals 7. Parking, facilities
3. Rail, commuter 8. Parking, planning
4. Bus, stations and shelters 9. Suburbs, business districts
5. Bus, commuter

Abstract: The report examines prototype commuter transportation centers for the suburban area north of Chicago. The concept refers to modal interface features of conventional railroad or rapid transit stations. The purpose of the report was to develop criteria for such transportation centers at which the interchange of rail passengers to automobile, bus, or other rail modes would be facilitated with maximum convenience.

Criteria for designing the prototype transportation centers were prepared with reference to: (1) the enclosed structure, (2) pedestrian circulation, (3) provision of commercial and other public facilities, (4) parking, (5) loading operations, and (6) landscaping. Each functional aspect of the efficient rail station is described briefly along with such general planning requirements as the estimated volume of commuter passengers and vehicles. Particular emphasis is focused upon convenience for the transit user; the authors note that the transit environment may be a principal factor in attracting new ridership. Consequently, such variables as walking distances, pedestrian access, passenger amenities, and functional design are emphasized in the analysis.

These criteria were employed to develop three prototype transportation center designs for application in different types of urban and suburban locations. Prototype A was designed for a point of maximum convergence (i.e. a major activity center with potential requirements for grade-separated platform and access facilities). Prototype B was designed for a village center where overall demand and passenger volume would be smaller, with less rigorous requirements for design. This design also assumes fewer constraints upon at-grade construction and greater opportunities for imaginative land use. Prototype C was designed for an outlying location where demand for both rail service and public feeder systems would be smallest. This design would be limited to at-grade construction. Estimated cost factors for each prototype design are provided.

The authors also discuss the possible impact of new transit technology on future station configurations. Although a major design criterion is capability for expansion (to handle likely increases in passenger volume), they note that space requirements for ticketing and parking facilities may actually decrease. The latter would be particularly true where dual-mode buses or Dial-A-Ride systems were introduced.

A final section details implementation procedures for commuter transportation centers. The discussion focuses on methods to determine local requirements both within and outside the context of a regional transportation plan. The authors also examine different sources of financing with reference to local contributions, parking fees, commercial leases or land sales, and participation in relevant Federal assistance programs.

NTIS Order #: PB-204-931
PC \$3.00, MF 95¢

Title: "Southward Transit Area Coordination Study"

Author: Illinois State Department of Public Works and Buildings

Date: UNDATED

Project No. ILL-T9-3

Keywords:

1. Bi-Modal System	7. Demography
2. Center City	8. Employment
3. Ridership, profiles	9. Poverty
4. Rail, commuter	10. Routes and Routing
5. Surveys	11. Quantitative Analysis
6. Financing Mass Transportation	

Abstract: The goal of the Southward Transit Area Coordination (STAC) study is to provide the technical basis for a short-range program of coordinated bus and rail mass transportation for the south side of Chicago, south suburban areas in both Illinois and Indiana, and the Chicago central business district (CBD). Equipment and service recommendations are limited to technology feasible within the next five years and recommendations for coordination of service for immediate implementation.

A transit ridership survey was conducted on all mass transit facilities serving the study area to determine the volume and travel characteristics of mass transit riders. The survey provides information on the transit mode selected for work trips and the characteristics of workers having common origins and destinations but traveling in different modes. Factors studied were: the distribution of peak morning work trips identified by the transit ridership survey, significant differences in the travel characteristics of commuter rail and surface bus trips, hourly patterns and factors, trip purpose and occupations of riders, service areas (envelopes of attraction), Chicago CBD versus other destinations, and the principal CBD destinations of riders. A discussion of the effect of CBD destination on carrier selection is also included.

Characteristics of the study area were examined to provide a basis for evaluating public transportation facilities serving the area. The status of common carrier transportation facilities in the STAC study area -- bus, railroad, and rapid transit -- is reviewed. A summary of recent ridership trends, together with a brief discussion of existing operational and financial characteristics, is presented for each of the 10 transportation carriers, including five railroads, four bus carriers, and the Chicago Transit Authority.

The STAC study developed predictive equations, by means of a multiple regression analysis, to estimate origins and destinations of passengers, and to identify the relationships between transit ridership, the level of transit service provided, and characteristics of the population. The report describes the methods used to identify these relationships and the results of applying them to predict future transit demands. The following independent variables were used to reflect the characteristics of the origin and destination zones: route miles of bus service per square mile, bus vehicle miles of service per square mile, number of buses providing service, and regional population, employment, income, and labor force. The report includes the findings and recommendations regarding coordination, carrier service and equipment, commuter rail station operations, rider costs, legislative and regulatory requirements, and an implementation program.

NTIS Order #: PB-204-034
PC \$3.00, MF 95¢

Title: "Transit Technical Study, South Bend-Mishawaka Area"

Author: W. C. Gilman and Company, Inc.

Date: May, 1969

Proj. #: IND-T9-1

Keywords: 1. Bus, intracity
2. Ridership, profiles
3. Survey
4. Trip Generation
5. Fares, cost determination
6. Demography
7. Government, urban
8. Routes and Routing
9. Maintenance
10. Financing Mass Transportation, requirements

Abstract: The concern of this report is with providing the residents of the South Bend-Mishawaka area with an action-oriented transit improvement program directed at optimizing transit ridership within an immediate to short-range (5 yr.) period.

The South Bend Public Transportation Corporation System (SBPTC) transports more than 9,000 passengers per day. School and work trips account for 77% of the average daily ridership; the remaining trips are for such purposes as personal business, shopping, and recreation. Of these average daily passengers, one-quarter use public transit as a matter of preference, while two-thirds use public transit as a matter of necessity (unavailability of a private automobile). Consequently, a significant portion of average daily transit riders are considered "necessity riders" -- citizens who have neither the economic and/or physiological capabilities to shift to an alternate mode of transport.

To optimize an improved program of transit ridership, the report notes that local governments must be responsive to the transportation needs of all segments of the community; the report also stresses the need for maintenance of the public transportation system.

Recommendations are confined to existing or available industrial equipment, practices, and procedures. The transit improvement program is to be one which, in the judgement of the consultant, achieves a proper balance between a public service-oriented philosophy and practical financial considerations.

To accomplish this objective, a study was conducted which included: (1) a transit rider origin-destination survey on a representative day to provide the basis for evaluating the effectiveness of present routes and to construct a transit rider profile; (2) a review of existing corporation financial and operating data to permit an objective cost analysis of present operations; and (3) an extended field trip to South Bend-Mishawaka during which time officials from the business, civic and educational communities were interviewed to encourage community involvement.

As a result of the aforementioned, recommendations were made: (1) to increase the adult and student token fare, the student token fare and the student cash fares; (2) to investigate federal assistance in supporting the reduced senior citizen fare; (3) to introduce a reduced fare service within downtown South Bend; (4) to expand one-way miles of transit routes; (5) to improve standards of service over the proposed route network; (6) to make application for federal assistance in the purchasing of new buses and in the refurnishing of the existing fleet; (7) to investigate potential sites for a new operating base; (8) to institute certain non-operating economies which do not affect bus service on the street, i.e. revised hours of operation, reduced management personnel, and improved maintenance efficiency; and (9) to implement a continuing transit promotion program.

Financial projections of operation are presented by year for the five-year period (1969-1973)

NTIS Order #: PB-194-359
PC \$3.00, MF 95¢

Title: "Mass Transit Technical Study: Iowa City (Final Report)" [Revised Edition]

Authors: Kenneth J. Dueker and James Stoner (University of Iowa, Institute of Urban and Regional Research)

Date: September, 1971

Proj. #: IOWA-T9-2

Keywords: 1. Bus, intracity 6. Trip Generation
2. Bus, feeder 7. Modal Split
3. Ridership, volume 8. Routes and Routing
4. Government, urban 9. Advertising and Promotion
5. Financing Mass Transportation, requirements 10. Management, operations and techniques requirements

Abstract: The report provides a comprehensive overview of bus transit in the Iowa City, Iowa, metropolitan area and a recommended short-range improvement program. Existing transport services are operated by a public agency receiving direct subsidies from the metropolitan government. The authors note that these operations reflect a characteristic profile of declining ridership and rising costs. The purpose of the report is to study current trends and to generate a plan for improving service.

Introductory textual material covers transit trends in the United States generally and in the Iowa City area. The authors note that the city contains a centralized business district and that a university serves as a principal trip generator. The authors' pervasive assumption is that transit services should supplement transportation by private automobile and that they should be relevant to those persons to whom automobiles are not otherwise available.

A comprehensive examination of transit trends in Iowa City and results of an on-bus survey are provided. System operations, gross ridership, routing, headways, fares, qualitative variables, trip generation, trip patterns, and ridership characteristics are discussed in detail. Based upon these data, the authors developed two alternative proposals for service improvement; these included a line-haul system focused on the downtown-campus area and a combination of line-haul routing and shuttle bus service. Both were determined to be economically infeasible within the fiscal capabilities of the municipality to provide subsidies.

A final recommended system is therefore proposed which compromises demand-responsive routing and costs. Eleven specific routes are delineated. In addition, several service standards are advanced with reference to headways, vehicles, hours of operation, and other relevant service factors. Estimated patronage on the new system was calibrated with a modal split model which employed various demographic data. A recommended fare structure was also synthesized. Detailed cost estimates are provided and compared with projected revenues. Finally, the authors examine four essential related activities: promotion and advertising, urban street improvement, parking development, and driver training.

The report concludes with a brief discussion of transit operation alternatives. The authors recommend creation of a regional transportation planning agency, and the report includes the draft of a proposed resolution for action by the local government. Legal aspects of transit operation are discussed with reference to statutory requirements. The recommended management option will make the Iowa City Transit System a regular division of the city government. Finally, the report concludes with a detailed evaluation of all equipment and other capital stock available to the transit system.

NTIS Order #: PB-204-994
PC \$3.00, MF 95¢

Index No. 2-IOWA-2.2

Title: "Owensboro Transit Study"

Author: Wilbur Smith and Associates, Inc.

Date: September, 1971

Project No. KY-T9-2

Keywords: 1. Public Ownership
2. Ridership
3. Trip Generation
4. Bus, cost
5. Bus, intracity
6. Financing Mass Transportation, sources
7. Fare, cost determination
8. Surveys
9. Small Cities

Abstract: The report is a comprehensive technical study of transit feasibility in Owensboro, Kentucky. The city is characteristic of many urban areas in the 25,000 to 50,000 population category which have lost their local transit systems in the past decade. Until 1969, Owensboro was served by a privately-owned bus company which discontinued its operations due to financial difficulties. The purpose of the present report was to determine whether and in what manner the City of Owensboro should re-establish bus service for its citizens.

In their introductory text, the authors examine the changing status of public transportation nationally with reference to community benefits, the trends toward public ownership, abandoned services, factors influencing transit usage, and available sources of state and Federal financial assistance. The report concludes that a public transportation system provides substantial benefits to the community which warrant a resumption of service.

Community factors and transit potential are examined in detail. The report describes previous service with reference to routes, service level, equipment, financial conditions, and fare structure. A survey was conducted throughout the urban area to determine transit demand and the availability of alternate transportation modes. These data indicated that in as many as half the households surveyed at least one member depended upon transit for a variety of trip purposes. Significantly, the trip generation data revealed that work trips were in least demand; the most frequently cited trip purposes were (in order) shopping, medical, social-recreation, and miscellaneous personal. The authors conclude that ridership demand would therefore be spread throughout the day, and that normal peaking effects would be minimal. Approximately 90% of all survey respondents favored a fare level of between 30 and 40 cents.

Based upon their analysis, the authors recommend public ownership and operation of a modified bus transit system. All relevant considerations for implementation of the proposed plan are examined including legal, routes, potential service expansion, schedules, fares, required equipment, and funding. Projected operating results are summarized according to two different patronage estimates.

NTIS Order #: PB-207-106
PC \$3.00, MF 95¢

Index No. 2-KY-2.1

185

Title: "Mass Transit Operations: Shreveport/Bossier City"

Author: DeLeuw, Cather & Company

Date: January, 1971

Proj. #: LA-T9-2

Keywords:	1. Bus, intracity	4. Public Ownership
	2. Bus, cost	5. Advertising and Promotion
	3. Financing Mass Transportation	6. Ridership
		7. Government, urban

Abstract: The report is a comprehensive technical study of mass transportation in the Shreveport and Bossier City (Louisiana) metropolitan area. The existing system of regular intracity bus service is characterized by a common profile of declining ridership and rising costs which cannot be met by farebox revenues alone. The purpose of the report was to examine present operations and synthesize specific recommendations for improving management and service.

The report begins with a detailed inventory and overview of the Shreveport Transit Company with reference to franchise rights, union contract provisions, routes and scheduling, equipment, ridership levels, current fare structure, costs and revenues, and capital investment. The authors note that existing facilities and equipment are adequate, but that ridership has declined dramatically in recent years. A 67% drop in overall patronage was recorded between 1960 and 1969. In addition, operating expenses have risen despite service reductions and a fare hike.

The authors conclude that such conventional measures as purchases of new rolling stock, fare increases, service alterations, or promotional activities cannot appreciably redress this decline. However, they note that continued mass transportation services are desirable both to promote the economic vitality of local commercial centers and to provide mobility for persons who otherwise lack access to an automobile.

Several specific recommendations are advanced to maintain the mass transportation service. With reference to management, the authors suggest creation of a regional-based public agency to acquire and operate the existing system. The agency would participate in Federal transit assistance programs and employ special tax revenues to subsidize deficit operations. The authors do not recommend changes in the basic routing network, but do suggest that routes converge on a central point to facilitate transfers. Some scheduling and promotional changes are also discussed to give the system a "new look".

The report concludes with a brief comparative discussion of bus transit in other cities, particularly in Wisconsin and Binghamton, N. Y. The analysis includes a table comparing financial data, operating statistics, and selected ratios (eg. passengers per 100 miles) among Shreveport Transit Company and nine other systems throughout the country.

NTIS Order #: PB-204-952
PC \$3.00, MF 95¢

Title: "A Report on Mode Choice Analysis for the Baltimore Region"

Author: Alan M. Voorhees & Associates, Inc.

Date: 1969

Project No. MD-T9-1

Keywords: 1. Modal Split
2. Ridership, volume
3. Quantitative Analysis
4. Private Transportation, automobile
5. Trip Generation

Abstract: The report is a comprehensive analysis of modal split in the Baltimore region. In their introductory text, the authors underscore the importance of reliable modal split projections in long-range transportation planning and in the allocation of public resources among different travel modes. Conventional analytic techniques attempt to divide the total passenger volume among automobile drivers, automobile passengers, and transit riders according to salient personal characteristic variables. Prior research indicated that the major determinants of transit patronage were trip purpose, relative mobility of tripmakers, availability of parking, and the relative ease afforded by private transportation.

The report also cites results of an earlier study of modal split in the Baltimore region which identified statistical relationships between certain key variables and the factors most influential in attracting transit ridership. These relationships were verified by a technique known as stratified regression analysis. Using this method, equations are developed for each trip purpose which correlate the related percentage of trips between any two zones to a sum of the values of several variables. The earlier study, however, assumed a linear relationship between transit usage and each variable. Further analysis revealed that as variable values approach the extremes, this linearity does not obtain. Consequently, the authors attempted to employ a more consistent technique for establishing modal split relationships.

A sensitivity analysis was undertaken using stratified curve analyses. In this technique, the base year data were stratified by several levels of the independent variables; data for each stratification cell were then plotted to develop preliminary curves which reveal the true form of the relationships. Adjustments to the preliminary curves were made to insure replication of the base year pattern. A Baltimore area modal split model was thus produced using the final set of stratified curves.

The report documents all relevant aspects of the analysis in detail. Separate models for estimating modal split and auto occupancy are described with reference to calibration methods, applied results, and submodels. The authors conclude that their model can be of significant value in predicting future transportation requirements for urban planners. In addition, they note that ridership levels are particularly sensitive to variations in service such that even minor system improvements could attract a substantial number of new work trips.

NTIS Order #: PB-191-366
PC \$3.00, MF 95¢

Title: "A Mass Transportation Technical Study. MASS-T9-2, Final Report"

Author: City of Lawrence, Massachusetts, City Planning Commission

Date: June, 1969

Proj. #: MASS-T9-2

Keywords: 1. Surveys
2. Employment
3. Elderly
4. Ridership, profiles
5. Routes and Routing
6. Schedules and Scheduling
7. Private Transportation, car pools
8. Bus, intracity

Abstract: The report summarizes results of a technical study project which assessed the responsiveness of public bus transportation to the demands of different user categories. Survey data were obtained with reference to employment, elderly ridership, social service agencies, and general patronage.

Employees in the Lawrence, Mass., area principally employ car pools for the work trip. These, however, do not adequately serve night shift personnel who frequently earn less and therefore have limited access to a private automobile. Surveys conducted among area employers revealed that most were dissatisfied with public bus service, but that they did not believe improved public transportation would divert their employees from the private mode. Existing bus schedules were found to be poorly coordinated with shift changes at major industrial plants.

Additional surveys of unemployed or underemployed persons revealed that mass transportation may be less crucial than supposed. Nearly 50% of all respondents in these categories owned an automobile, and only 1/4 of all workers used public transportation. Furthermore, 75% of those surveyed indicated that they would not travel more than 30 minutes to reach a better job. Many, however, did cite a need for improved bus transportation.

Elderly citizens constituted a large proportion of regular bus users, but many responded that physical barriers prevented them from riding more often. The authors note that such problems as long walks from bus stops and waiting time were frequently cited. Surveys were also taken among 26 social service agencies in the area to determine their relationship with public transit. The authors note that none of the agencies felt they relied upon the local bus system, but that most expressed dissatisfaction with present service levels. It was also noted that many of the agencies had recently relocated in a new building which was not served by any existing bus routes.

A bus-stop survey was conducted among random transit passengers. More than 85% had taken no more than three minutes to arrive at the bus stop, and most took only short trips without transfers. Significantly, however, nearly 65% came from families owning one or more cars. The most frequently cited recommendation for improved service involved point-to-point transportation.

No specific transit improvements are recommended in the report. In general, however, the authors note that routing and service improvements should constitute priority items on the agenda. Experimentation with a Dial-A-Ride bus or other demand responsive system is also recommended.

NTIS Order #: PB-185-962
PC \$6.00, MF 95¢

Title; "Central Area Systems Study - Volume I"

Author: Massachusetts Bay Transportation Authority

Date: June, 1971

Proj. #: MASS-T9-4

Keywords:	1. Rail, systems planning and design	6. Tracks and Trackage
	2. Vehicle, design	7. Rail, rolling stock
	3. Financing Mass Transportation	8. Rail, stations and terminals
	4. Maintenance, facilities	9. Inner City
	5. Communications	10. Government, Federal

Abstract: This report summarizes the results of the Central Area Systems Study (CASS) project. This study was conducted by the Massachusetts Bay Transportation Authority's Planning and Development Department, with Federal aid funding 2/3 of the cost. The CASS research developed a course of action for the Authority to follow in modernizing its vital Green Line (streetcar system). The study was also expanded to cover the Blue Line (East Boston rapid transit line).

The Green Line has serious problems which affect its performance in terms of capacity, speed, reliability, comfort, and operating cost. Its network of routes is operated entirely with a fleet of aging streetcars of the "PCC" type. The facilities for control, communications, and vehicle maintenance can only be called primitive by today's standards, especially when one considers that the Green Line is the backbone of the entire Massachusetts Bay Transit Authority (MBTA) system. It serves as a major feeder and distributor for the other transit lines, and carries many more daily riders than any of the other three major lines. In-depth analyses of the inner cities area and the nature of the neighborhoods served by the Green Line were conducted. It was revealed that the Green Line's core area of service is much larger than was realized at the beginning of the CASS Project.

The physical condition and performance of the Green Line, and especially the "PCC" type streetcars currently in use, are such that the authors recommended that the highest priority should be assigned to implementation of the following program: (1) acquisition of 220 new air-conditioned "Light Rail" surface-subway cars to replace the entire of fleet of cars currently being used; (2) construction of a new vehicle maintenance facility at the Riverside terminal; (3) modernization of the Reservoir Car House to provide for efficient routine inspection, cleaning, and light repairs for a portion of the Green Line fleet; and (4) track and roadway improvements on the Riverside Line, Central Subway, and Lechmere Viaduct, which would include the installation of emergency crossovers, turnback facilities, and certain station improvements.

NTIS Order #: PB-204-468
PC \$6.00, MF 95¢

Title; "Central Area Systems Study - Volume II"

Authors: DeLew, Cather & Company

Date: June, 1971

Proj. #: MASS-T9-4

Keywords: 1. Rail, systems planning and design
2. Rail, rolling stock
3. Modal Split

Abstract: The purpose of this report was to determine the physical feasibility and the cost of alternative improvements for the Central Area subway system and for possible extensions of rail transit service to the Needham and Framingham areas. The study area was defined as that part of Boston, termed the Central Area, that lies within the route of the proposed Inner Belt Highway.

The major public transportation arteries serving the Central Area are four rail transit systems, called the Red, Orange, Blue and Green Lines in accordance with their identifying color schemes. Each transit line passes through the Central Business District in its own subway. Passengers can transfer at interchange stations, but there are no track connections between lines. Presently, it is not physically possible to run the equipment of one line on any of the other lines due to the differences in clearances and platform heights.

Studies of the deficiencies in the existing transit system were primarily directed toward the serious operational problems afflicting the Green Lines. The cars operating on the Green Lines are all of the PCC type, some of which are nearly 30 years old. They have inherent limitations such as single-end operation, low-level platform loading, and insufficient door capacity. In addition, it has become increasingly difficult to keep these cars in operating condition. Breakdowns are frequent, repairs are costly, replacement parts are difficult to obtain, and maintenance facilities are poorly located, small, and obsolete.

The authors developed an Immediate Action Program of improvements for swift implementation. It is recommended that the Massachusetts Bay Transit Authority acquire, as soon as possible, new rolling stock for the existing Riverside and Huntington Avenue Lines. The Riverside and Central Subway physical plant should be upgraded to permit full use of the technological improvements incorporated in the new equipment.

It is recommended that as a long range improvement plan, a new subway connection be constructed from Back Bay via Columbus Avenue, Boston Common, and Beacon Hill to the existing Blue Line Station at Bowdoin. New stations would be provided at Stuart-Eliot Streets and at Park Street. Not only would the Green and Blue Lines be interconnected, but the transfer capability of the entire downtown transit network would be improved by virtue of the interfaces at Back Bay and Park Street Stations. The Beacon Street and Commonwealth Avenue Lines would continue to operate in the improved Central Subway. The total estimated cost of the proposed program is \$59,500,000.

NTIS Order #: PB-204-469 -U
PC \$3.00, MF Not Available

Title: "Central Area Systems Study: Volume III" [Oversize Document]
"Central Area Systems Study: Volume IV" [Oversize Document]

Author: DeLeuw, Cather & Company (Vol. III)
Colonel S.H. Bingham Associates, Inc. (Vol. IV)

Date: June, 1971 (Vol. III) Project No. MASS-T9-4
February, 1971 (Vol. IV)

Keywords: 1. Rail, systems planning and design 5. Communications
2. Maps and Mapping 6. Signs and Signals
3. Routes and Routing 7. Power Distribution
4. Airport, access 8. Rail, stations and terminals

Abstract: The reports document appended material and graphic exhibits to supplement a comprehensive technical study of proposed rapid transit in the Boston metropolitan area. The work was sponsored as part of the Central Area Systems Study, an in-depth analysis of people and goods movement through the regional core.

Volume III delineates the proposed route configuration for all segments of the rapid transit system. Scaled aerial maps are provided for consecutive segments of approximately 2,000 feet; adjacent land usage and station sites are noted. Vertical, cross-sectional maps are also included to indicate gradation and slope of both the proposed guideways and subsurface tunnels. The report concludes with scaled architects' plans for the rapid transit stations and terminals.

Volume IV is a detailed cost analysis of the recommended system. A description of project tasks and costs associated with each of four development phases is provided. Additional cost estimates are broken down among three component subsystems: (1) communications, (2) signals, and (3) power distribution. The proposed communications subsystem will consist of advanced train-to-wayside radio, inter-station telephone links, and a public address system. Four-phase implementation programs for signals and power distribution are also described in detail. Total construction costs are estimated at greater than \$150 million.

Using the cost estimates and route configurations delineated above, the authors conducted a rigorous feasibility analysis for each phase of the proposed construction plan. Phase I would consist of improving transfers between a commuter railroad and the rapid transit line and constructing a commuter parking area for some 2,000 automobiles. Total costs for this phase are estimated to be in excess of \$28 million, and the authors recommend that it be approved. Phase II would provide express transit service between the county airport and a proposed terminal at a cost of more than \$48 million. The authors conclude that limited savings of travel time between these points do not justify approval of the Phase II plan. The Phase III proposal would provide direct rail access to Logan International Airport, and connect major trip generators via subway. Total costs for this phase are estimated to be \$26 million; the authors conclude that substantial benefits would be accrued from the diversion of automobile users to rapid transit, and that the construction should therefore be approved. Because the proposed Phase IV construction is contingent upon approval of Phase II, the authors do not recommend its implementation.

NTIS Order #: [Vol. 3] PB-204-478-U
" " " [Vol. 4] PB-204-479-U
Each Volume: PC \$3.00, MF Not Available

Index No. 2-MASS-4.4

Index No. 2-MASS-4.5

Title: "Feasibility of Moving Walks/Boston: Overview"

Author: The Boston Redevelopment Authority

Date: January, 1971

Proj. #: MASS-T9-5

Keywords: 1. Distribution Systems 5. Center City
2. Sidewalks 6. Access, planning and control
3. Pedestrians 7. Speed and Speed Control
4. Conveyors

Abstract: The report is a comprehensive overview of planning, design, engineering and implementation of a moving walkway system for the Boston central business district. The purpose of the walkway will be to supplement existing mass transportation by providing a convenient distribution-delivery system. The walkway will serve principal trip generators to which passengers do not otherwise have simple access by conventional modes or by unassisted walking. The planning framework is examined in detail with reference to existing problems, general system requirements, and a proposed moving walkway configuration. Subsequent chapters summarize transportation requirements; engineering considerations; design elements; and legal, administrative, and cost ramifications of the walkway proposal outlined in other reports generated by MASS-T9-5. Existing and projected transportation requirements are analyzed to yield minimum design capacity specifications for the moving walkway. Existing pedestrian volumes and travel characteristics are assessed within selected high-density corridors, and used to estimate demand for the walkway in two scenarios.

Engineering considerations focus upon the relative advantages of constant speed and passenger-accelerating systems. The former operates with a continuous belt moving at low speeds (less than 2 mph) to permit direct access to and from the walkway. Passenger-accelerating concepts operate at higher speeds (4+ mph) and require more sophisticated engineering to integrate belts moving at successively faster speeds to permit safe passenger access. The authors examine the latter concept in both continuous feed and batch feed (in which passengers enter the system in small cars or gondolas) configurations. Walkway components, including treadways, suspensions, combplates, handrails, and propulsion unit, are outlined along with a brief history of the concept in application. The report also assesses contemporary state-of-the-art with reference to existing installations, manufacturers, general characteristics, capacity, design advances necessary for implementation, maintenance and mechanical problems, passenger comfort, and regulations.

Six concepts of the accelerating beltway are analyzed in detail and compared against constant-speed systems. The authors conclude that because of greater capacity, speed, and applicability to the demonstration site, the former moving walkway system would be advantageous, although all but one of the six concepts examined lack sufficient engineering maturity for immediate application.

Design elements concern specific aspects of the proposed demonstration site along Summer Street. Engineering requirements which result from existing site conditions are delineated along with a detailed analysis of the corridor itself, emphasizing right-of-way location, alignment, access, construction materials, environmental control, and other relevant factors. Textual material is supplemented by graphic illustrations and maps of the projected moving walk route. Additional chapters examine legal barriers to implementation (including proposed legislation), administration of the project, and cost estimates broken down for each proposed system.

NTIS Order #: PB-202-015
PC \$3.00, MF 95¢

Title: "Feasibility of Moving Walks/Boston -- A: Transportation"

Author: Murray D. Segal, Transportation Consultant

Date: January, 1971

Proj. #: MASS-T9-5

Keywords: 1. Pedestrians 7. Conveyors
2. Sidewalks 8. Surveys
3. Trip Generation 9. Center City
4. Land Use 10. Traffic, Peak-Hour
5. Urban Development, planning 11. Access, planning and control
6. Urban Development, renewal

Abstract: The report summarizes detailed studies relating to pedestrian travel within the demonstration corridor for a moving walkway system in Boston. The data cover all relevant aspects of pedestrian volume, travel characteristics, and trip generation, and alternative configurations for the beltway are developed. The moving walk concept was developed to function in conjunction with proposed massive redevelopment of the Boston central business district and to provide supplementary distribution-delivery service for conventional modes of public transportation. Three basic objectives of the walkway implementation were: (1) separation of pedestrian and vehicular movements, (2) provision of an alternate pedestrian access mode to the corridor to reduce congestion at the area's nearest subway station, and (3) reduction of travel times within the central business district to encourage greater use of fringe parking facilities.

Existing pedestrian characteristics were identified through comprehensive survey procedures which are detailed in the report. Data were obtained with reference to both pedestrian volume and travel patterns. The authors outline material covering pedestrian flow, hourly variations, trip generation, origin-destination patterns, walking distances, and modal split by trip purpose. These data were employed to synthesize projected pedestrian travel characteristics after redevelopment programs alter land use in the downtown corridor. Planned development projects for the area are discussed in detail, and the report summarizes the estimated demand for moving walkways within two possible traffic assignment models. These conclusions are then applied to yield location and capacity recommendations for the moving walkway.

Appended material documents raw survey data and processing methodology for the studies of pedestrian volume characteristics, travel patterns, trip generation, and projections of demand for the moving belt. Analysis methodology for trip generation, distribution, and assignment (by which the recommended system location and capacity was determined) is also appended.

Several general observations and conclusions are advanced which generally pertain to the specific system configuration for Boston. The report notes, however, that planned redevelopment of the central business district will have substantial impact upon walkway feasibility and that without the proposed changes in urban land use, estimated demand will be insufficient to warrant construction. The author also recommends construction of a second moving walk along the east-west segment which would be elevated and would handle excess demand estimated to outstrip the capacity of a single belt.

NTIS Order #: PB-202-016
PC \$3.00, MF 95¢

Title: "Feasibility of Moving Walks/Boston -- B: Engineering"

Author: Jackson and Moreland Division of United Engineers and Constructors, Inc.
(for Boston Redevelopment Authority)

Date: January, 1971

Proj. #: MASS-T9-5

Keywords:	1. Sidewalks	5. Center City
	2. Conveyors	6. Distribution Systems
	3. Speed and Speed Control	7. Safety
	4. Interfaces	8. Quality Control

Abstract: The report summarizes engineering requirements and alternatives for a proposed moving way system in the Boston central business district. The system would provide pedestrian access and distribution services within a high-density commercial area now slated for major redevelopment. Conventional moving ways which employ a single, continuous belt moving at constant speeds of less than 1.5 mph were found to be the only such systems capable of immediate application. The authors conclude, however, that because these belts are slower than walking, they do not constitute a practical alternative for the Boston demonstration.

The report focuses on various accelerated-speed moving way systems which employ sophisticated engineering technology to move pedestrians at speeds of up to 4 mph. Six specific design configurations are analyzed, including: (1) multiple belts in linear array, (2) constant linear accelerators, (3) variable platen lengths, (4) side-loading oscillating elastic aprons, (5) moving belt gondolas, and (6) Bouladon Integrator systems. These alternative systems were analyzed according to their relative advantages and disadvantages, and an optimal network concept was recommended using the multiple belt approach. This system employs a series of moving belts in linear array each turning at a relatively faster speed than the one immediately preceding. Passengers can therefore step from one to another for safe acceleration, arriving finally as the fastest-moving central belt. Relative cost differences among the six alternative designs are detailed, along with a breakdown of projected expenses for implementation, operation, and maintenance of the recommended system.

General requirements for construction of the moving way are discussed with reference to routing, stations and transfer points, power distribution, and maintenance. Correlation of the recommended concept within the general planning framework of the Boston redevelopment program is also examined.

The report outlines general engineering aspects of moving way systems, and contains a history tracing development of the concept since the mid-1800's. Particular emphasis is given to the development of new technology and to current research into the feasibility of accelerated-speed configurations. State-of-the-art in conveyor design and engineering is examined in all relevant aspects, including present manufacturers, capacity, access, speed, acceleration, passenger stabilizers, propulsion and suspension systems, ride quality, overall specifications, noise and vibration levels, construction materials, safety and operational reliability, guideway protection, maintenance, and other design considerations. The analysis also focuses on the human-machine interface with particular emphasis on human engineering requirements, human tolerances to acceleration and vibration, and evaluative models.

The report concludes with detailed citations from industry and governmental regulatory safety codes pertinent to the construction of a moving way system.

NTIS Order #: PB-203-859
PC \$6.00, MF 95¢

Title: "Feasibility of Moving Walks/Boston -- C: Design"

Author: The Architects Collaborative, Inc.

Date: January, 1971

Proj. #: MASS-T9-5

Keywords: 1. Conveyors
2. Distribution Systems
3. Sidewalks
4. Pedestrians
5. Information Aids
6. Signs and Signals
7. Urban Development, planning
8. Handicapped

Abstract: The report summarizes comprehensive design criteria and specifications for a moving way system in the Boston central business district. The proposed system will employ a network of continuous, automated belts for pedestrian circulation throughout a central city area currently slated for major redevelopment. The purpose of the report was to define site conditions, general design criteria, and specifications for the moving way system.

The report examines features of the corridor study area with reference to existing functional areas and land uses, sub-area development, climatic conditions, and traffic. The general design methodology is described in detail with particular attention given to planning objectives for vehicle and pedestrian circulation. These basic considerations are then applied to each of two corridors in which the moving way systems will be located. Architects' drawings of the proposed configuration are provided. Design considerations are discussed with reference to both physical features of the respective corridors and system components. Construction materials, structural design, and environmental controls are also examined.

The report discusses implementation procedures with reference to phasing, costs, maintenance, legal constraints, and coordination with the public transit system. In addition, the report contains a detailed summary of proposed graphics for signs, maps, and other information aids. Specifications for the graphic materials are provided with reference to lettering, location along the route, typography, color, and materials.

Appended material includes special design considerations for the handicapped, visual aspects of graphics design, summaries of preliminary studies, and a proposed system alignment configuration. The report contains detailed area maps of the corridors which locate proposed moving way routes as well as schematic diagrams of stations and structures.

NTIS Order #: PB-202-017
PC \$6.00, MF 95¢

Title: "Feasibility of Moving Walks/Boston -- D: Legal"

Authors: Ely, Bartlett, Brown & Proctor, Attorneys at Law

Date: January, 1971

Proj. #: MASS-T9-5

Keywords: 1. Government, state
2. Government, urban
3. Government, intergovernmental relations
4. Safety
5. Distribution Systems
6. Sidewalks

Abstract: The report examines legal considerations in the construction of a moving walkway for application in the Boston central business district. The proposed system would employ continuous conveyors to provide distribution-delivery service within a high-density pedestrian corridor and in conjunction with massive redevelopment of the downtown area. The report focuses on obtaining legal authority to construct the walkway and litigious implications of the system in operation.

The report notes that authority to construct new systems of urban transportation must generally be sought from the state legislature. Statutes granting such municipal authority are premised on a concept of state sovereignty which allows local government only those powers specifically delegated by the state. Several legal precedents under which statutory power to construct urban mass transportation (eg. the Boston subway system) was granted by the Massachusetts legislature are documented. The report also provides a thorough examination of existing provisions and precedents under which enabling legislation for the moving walkway implementation could be enacted. The analysis finds no fundamental legal barriers to authorization, and is provided mainly to identify the statutory framework within which such an authorization would be fashioned.

Proposed legislation is recommended primarily to clarify the existing law with specific reference to moving walkway systems. The suggested petitions would provide legal definition of the concept, stress its distinctiveness from transportation modes already provided for by statute, permit a division of responsibility for the system between the City of Boston and the Redevelopment Authority, and specify safety and inspection requirements.

Legal implications of the system in operation are discussed with reference to maintenance and potential liability, security and supervision, regulation, and proposed easement. The analysis gives particular attention to the litigation of suits instituted by riders claiming damages or injury from defective service. Relevant precedents are summarized in detail, emphasizing liabilities incurred by the Redevelopment Authority and by the beltway manufacturer. The report also examines the need for adequate supervision of the system to guard against both equipment malfunction and possible security problems leading to negligence suits. Appended material documents specific passages from the law and the draft of a proposed easement.

NTIS Order #: PB-202-018
PC \$3.00, MF 95¢

Title: "New Approaches to Public Transportation in the Northern Middlesex Area"

Author: Northern Middlesex Area Commission

Date: June, 1970

Project No. MASS-T9-6

Keywords: 1. Bus, school bus
2. Bus, cost
3. Bus, intercity
4. Ridership
5. Trip Generation
6. Public Ownership
7. Management, operations and techniques
8. Routes and Routing
9. Schedules and Scheduling
10. Fare, cost determination
11. Youth
12. Government, urban

Abstract: The report is a comprehensive technical study of public bus transportation in the Northern Middlesex Area of Massachusetts. Regional bus services are currently provided by the Massachusetts Bay Transportation Authority and local private carriers; the authors note that little coordination among different segments of the transit network has been effected. Route coverage and service levels have undergone little change since the 1950's, although demographic patterns and the location of principal trip generators have changed substantially. As a result, many high density areas receive insufficient service while elsewhere, ridership demand has declined below the point which warrants continuation.

Existing transportation services are described in detail with reference to conventional bus, school bus, rail, and taxicab service. Travel characteristics were ascertained for trip generation, trip distribution, modal split, and other relevant parameters. The authors calculate potential public transportation demand given projected changes in regional socio-economic variables, retail trade, employment, and travel patterns. A substantial latent demand for transit service was indicated.

Two current management proposals are explored at length. These include: (1) creation of a regional transportation authority, and (2) contracting with a private carrier to provide consolidated services with a guarantee against assessments for operating deficits. Five other administrative options are also examined. The authors note particularly that financial arrangements will be the key determinant in selecting an optimal management structure. The report recommends that a local transportation area be established until necessary legislation to create a transit authority is obtained.

A wide variety of service alternatives are analyzed for improving bus transit generally. These are broken down among four basic categories, including: (1) pupil transportation, (2) routes and schedules, (3) equipment, and (4) fare structure. The authors recommend a preferred system comprised of the following features: (1) school bus service limited to grade school students only, (2) a network-demand actuated route and scheduling policy, (3) a mix of vehicles in the bus fleet, and (4) a flat fare with free transfers. Long-range proposals are also suggested with reference to route revisions, fare changes, and marketing.

Appended material includes a computer analysis of the socio-economic characteristics associated with trip generation, a youth transportation survey, and a summary of transportation area legislation.

NTIS Order #: PB-197-958
PC \$3.00, MF 95¢

Title: "Regional Bus Transportation in Southeastern Michigan. Volume I:
Description of Present Operations"

Authors: Coverdale and Colpitts, Consulting Engineers

Date: April 1, 1969 Proj. #: MICH-T9-1

Keywords: 1. Financing Mass Transportation 4. Maintenance, Facilities
2. Fares, cost determination 5. Ridership, volume
3. Bus, cost 6. Management Operation and Techniques

Abstract: The Southeastern Michigan Transportation Authority (SEMPTA) has been granted the power to acquire and operate existing transit systems in southeast Michigan. There are eight bus systems which meet the legal definitions of eligibility for acquisition by SEMPTA and which would logically comprise a unified system under its administration. This report describes the operations of these eight bus transit systems.

This study contains an in-depth analysis of: (1) all physical assets of the transit systems, including vehicles, garages, shops and offices, and a determination of the condition of the vehicles, structures and principal items of equipment; (2) records pertaining to ownership, franchises, balance sheet data and the operation of transportation; (3) data respecting annual passenger revenue, rates of fare, other operating income, non-operating income, and any other sources of revenue; and (4) maintenance and operating practices.

The eight systems studied vary widely in size and in other characteristics, particularly profitability. The Department of Street Railways (DSR), City of Detroit, however, is by any standard the predominant carrier involved. The near-term financial results of a unified system would be very greatly affected by DSR's current financial situation. DSR has a reasonably stable patronage, and its operating costs with one significant exception, are within the range normally experienced by the transit industry. Nevertheless, it has been unable in recent years to maintain a sound financial situation. This is largely attributable to heavy operating expense resulting from payments to the City of Detroit's pension plan which are disproportionately high compared with pension expenses in the transit industry generally.

The authors recommend that a continuing external source of revenue be established, augmenting the revenue received through the fare box, to assure full implementation of the goals of the Metropolitan Transportation Authorities Act of 1967.

They further recommend the development and maintenance of management tools to aid in the administration of a unified operation of bus transportation.

NTIS Order #: PB-191-195
PC \$3.00, MF 95¢

Title: "The Transit Rider -- 1968: Interim Report #1"

Author: Simpson & Curtin, Transportation Engineers

Date: September, 1968

Project No. MINN-T9-1

Keywords: 1. Ridership, profiles 6. Sex
 2. Surveys 7. Private Transportation, automobile
 3. Bus, commuter 8. Quantitative Analysis
 4. Trip Generation 9. Center City
 5. Age

Abstract: The report is one volume in a comprehensive technical study of urban mass transportation in the Twin Cities metropolitan area. Its purpose was to document the results of surveys conducted among more than 150,000 daily adult revenue passengers using the eight transit systems currently serving Minneapolis-St. Paul and environs. The data collected embrace all relevant aspects of the ridership profile and travel patterns.

Characteristics of the transit riders were examined with reference to four analytic parameters, including: (1) sex and age, (2) annual family income, (3) automobile ownership, and (4) captive and choice riders. The data revealed that three passengers in four are women and that about 20% are senior citizens; these figures held constant among the eight regional bus companies and varied only slightly from data collected ten years previously. Family income statistics differed significantly between the inner-city and suburban routes; overall, more than 1/3 of the total ridership volume was from families earning less than \$6,000 per year. Automobile ownership was relatively high among Twin Cities bus riders -- almost one-half of the regular bus users were car owners, and an additional 17% owned two or more automobiles. However, the surveys also indicated that 75% of all ridership was "captive" (ie. did not have regular access to an automobile); 81% of all captives were women.

The surveys also developed a comprehensive profile of trip patterns throughout the region with reference to route patronage, transit travel to the central business district, school trips, trip purposes, and travel means to and from the bus. Survey methodology is outlined in detail. The report identifies principal travel corridors in the metropolitan area. More than 2/3 of all patronage was generated by work trips; a similar majority did not have conveyance to bus stops. Trip attractions in the two central business districts of Minneapolis and St. Paul were readily identified along with travel demands by students at the nearby University of Minnesota.

The report does not propose specific recommendations for transit improvement. Rather, its purpose was to provide a comprehensive data base with which such future proposals could be fashioned.

NTIS Order #: PB-195-838
PC \$3.00, MF 95¢

Title: "Transit Services: 1968 Appendix -- Interim Report 2a"

Author: Simpson & Curtin, Transportation Engineers

Date: December, 1968

Project No. MINN-T9-1"

Keywords: 1. Routes and Routing
2. Maintenance, facilities
3. Bus, intracity

Abstract: The report contains two appendices outlining 1968 transit services in the Minneapolis-St. Paul metropolitan area. (The main report appears as a separate document generated by MINN-T9-1.)

Appendix A provides detailed route information for all regular lines served by Twin Cities Lines, Inc., the area's largest bus operator. Data are broken down with reference to function, area served, route miles, stop spacing, headways, buses in service, and average weekday passenger volume. In addition, the report notes average speed, annual costs and revenues, and related operating statistics for each route.

Appendix B provides brief descriptions of transit garage facilities operated by Twin Cities Lines and each of five suburban companies.

NTIS Order No. PB-195-840
PC \$3.00, MF 95¢

Title: "Operating Results, 1968 -- Interim Report #3"

Author: Simpson & Curtin, Transportation Engineers

Date: March, 1969

Project No. MINN-T9-1

Keywords: 1. Financing Mass Transportation, sources 3. Bus, cost
 2. Fare, cost determination 4. Government, taxation

Abstract: Operating results of Twin Cities Lines (TCL), Inc. are reviewed in detail for the year 1968. All relevant statistical material is covered, including transit patronage and service, trends in operating costs, formulae for allocating costs among individual routes, allowable returns analysis, and fare structure.

TCL is the principal operator of bus transit in the Minneapolis-St. Paul metropolitan area. The analysis reveals a 25% decline in ridership over the past 10 years; during this same period, service (measured in vehicle miles per revenue passenger) has remained generally constant. Operating expenses were shown to account for a sizeable portion of current deficits.

The authors focus particular attention on proposals to increase the present flat fare of 25¢. The report concludes that attempts to increase this fee may prove counterproductive, since it is believed that the convenient and inexpensive fare accounts for some 12,000 additional daily riders. Alternative financing arrangements are recommended.

Three possible means of increasing income without an offsetting erosion of patronage are discussed at length. These include: (1) a general improvement program designed to increase vehicle and management productivity; (2) reevaluation of special reduced fares for school children, preferably through a public subsidy of the 5¢-per-ride difference; and (3) exemption of TCL from various taxes through special legislation.

NTIS Order #: PB-195-841
PC \$3.00, MF 95¢

Title: "Public Attitudes Toward Transit -- Interim Report #4"

Author: Simpson & Curtin, Transportation Engineers

Date: April, 1969

Project No. MINN-T9-1

Keywords: 1. Surveys
2. Community Response
3. Ridership, profiles
4. Trip Generation
5. Modal Split
6. Bus, intracity
7. Financing Mass Transportation, sources
8. Fare, cost determination
9. Highway, planning
10. Private Transportation, automobile
11. Intermodal Competition

Abstract: The report summarizes a comprehensive survey of public attitudes toward transit. A representative cross-section of persons living in the Minneapolis-St. Paul metropolitan area were interviewed to obtain data in four major areas: (1) present transit usage, (2) opinions on various transportation issues, (3) factors influencing mode choice, and (4) qualitative opinions of existing service. A detailed description of sampling techniques and a reproduction of the 11-page survey questionnaire are appended.

Present transit usage was studied both in the aggregate and as a function of demographic variables. Most residents agreed that a continuing program to improve local bus service should be encouraged and that fares should be reduced for school children. Eight respondents in ten agreed upon the desirability of downtown bus priorities, reduced fares for senior citizens, "balanced" transportation planning, and the diversion of automobile commuters to transit.

The survey also revealed consensus among seven out of ten respondents concerning the need to spend more money on improving bus service. These residents agreed that good bus service increases property values, that separate traffic lanes on urban freeways should be set aside for peak-hour commuter buses, that some new system (such as rapid transit) should be implemented, and that formation of the regional Transit Commission was a desirable first-step towards solving the area's transportation problems.

Almost no consensus whatever prevailed on propositions concerning: (1) user charges as the sole revenue base for transit operations; (2) increased public attention to transit at the expense of automobile facilities; (3) the expenditure of additional public funds to improve highways; (4) subsidies for transit operators unable to meet expenses through farebox revenues; (5) the emphasis on new systems, rather than buses, to supply future transportation; (6) public ownership of all transit facilities; and (7) the role of new highway construction to relieve existing transportation problems.

A proposal to fully underwrite transit fares with public revenues was rejected by 90% of all interviewees.

NTIS Order #: PB-195-842
PC \$3.00, MF 95¢

Title: "Evaluation of Alternative Service Improvements -- Interim Report #6"

Author: Simpson & Curtin, Transportation Engineers

Date: July, 1969

Project No. MINN-T9-1

Keywords: 1. Bus, cost
2. Bus, intracity
3. Bus, priorities
4. Signs and Signals
5. Management, operations and techniques
6. Fare, cost determination
7. Benefit-Cost Analysis

Abstract: The report evaluates several proposals for transit improvement in the Minneapolis-St. Paul metropolitan area. The discussion was intended to reflect professional and public reactions to the potential service recommendations outlined in an earlier report generated by MINN-T9-1.

Specific items covered in this report include: (1) a major bus purchase program; (2) use of minibuses to supplement existing service; (3) consolidation of Twin Cities Lines maintenance operations in two, rather than the present three, garage facilities; (4) a priority program for bus shelter location; (5) selection of proposed park-and-ride sites; (6) a major project to replace bus stop signs; (7) use of electronic computers for scheduling purposes; (8) application of two-way bus radios; (9) reserved traffic lanes for transit vehicles; (10) a device enabling bus drivers to actuate a particular phase of specific traffic signals; and (11) the creation of a centralized public information system.

The effect of various route changes on network patronage, revenue, and operating cost is discussed along with projected results of a suggested alternative fare plan. Benefits and costs for alternative improvement packages are also examined.

NTIS Order #: PB-195-843
PC \$3.00, MF 95¢

Title: "Implementation of Transit Improvements -- Interim Report #7"

Author: Simpson and Curtin

Date: October, 1969

Proj. #: MINN-T9-1

Keywords: 1. Public Ownership
2. Maintenance, facilities
3. Financing Mass Transportation,
requirements
4. Bus, stations and shelters
5. Government, Federal

Abstract: This report is the last of seven Interim Reports relating to the analysis of present bus operations in the Minneapolis/St. Paul Twin Cities area. This study provides a plan for implementation of the improvement program which was developed in earlier parts of the study, and which was designed to remedy the deficiencies of transit in the Twin Cities in the immediate future. The cost of improvements, the institutional framework, and the staging of capital expenditures are outlined, along with a consideration of financial resources.

The transit five-year improvement program developed from earlier evaluations of transit services, operating results and transit rider characteristics and attitudes is composed of the following components: (1) a bus purchase program to reduce the average age of the local transit fleet from 13 years to less than six years; (2) consolidation of garage facilities, from three to two locations; (3) the installation of passenger waiting shelters at 88 locations in the Twin Cities area; (4) the use of electronic computers for the scheduling of buses; and (5) the establishment of reserved lanes for transit vehicles. This program involves a capital expenditure of \$18.7 million. This outlay will produce a number of intangible benefits to the transit riding public in the way of faster, more extensive, and more comfortable service. In addition, 14,000 new passengers per day will be attracted to the system. Increases in revenues, after the deduction of operating expenses for the program, will amount to \$1.4 million in a typical year, while collateral benefits to the community will add another \$1 million.

It is the opinion of the authors that the improvement program cannot be effectively implemented with continued private ownership of the transit company. Public ownership by the Twin Cities Area Metropolitan Transit Commission is recommended as the institutional framework for implementing the improvement program. Yearly tax savings of almost \$1 million, and federal assistance, would become available to public owners of the transit company, and the cost of new capital would be considerably reduced.

Acquisition of Twin City Lines, and the subsequent improvement program, could be financed out of transit operating surplus, and the income from the Transit Commission "Wheelage" tax, along with Federal financial assistance.

NTIS Order #: PB-195-845
PC \$3.00, MF 95¢

Title: "A Transit Development Program for Lee County, Mississippi"

Author: Alan M. Voorhees & Associates, Inc.

Date: February, 1971

Project No. MISS-T9-1

Keywords: 1. Management, operations and techniques
2. Bus

Abstract: The report summarizes a comprehensive technical study of Lee County, Miss. This formerly rural area has experienced considerable recent growth which is attended by increasing demands for improved public services, notably transportation. As a basis for long-range transit development, the authors review demographic and economic trends in the area.

The potential for transit improvement is discussed in detail. Surveys of area residents and employers indicated substantial demands for public transportation which were not being served by the existing bus system. The report notes particularly that the population includes significant numbers of persons to whom travel by automobile is unavailable. This group includes the poor, the young, the elderly, and handicapped persons.

The report recommends that immediate action be taken to improve and expand the existing transit service. Travel patterns in the county were reviewed to develop a proposed optimal routing system. All aspects of the recommended system are discussed. The authors also recommend that the system be owned and operated by an independent, county-wide public body. The acquisition of new buses and a proposed fare structure are noted along with such supplementary considerations as garage facilities, passenger amenities, on-street amenities, public relations, and related services. A ten-year schedule of proposed transit improvements is outlined.

NTIS Order #: PB-204-063
PC \$3.00, MF 95¢

Index No. 2-MISS-1.1

208

Title: "Transit Technical Study -- Mississippi Coast Transportation Authority"

Author: Wilbur Smith & Associates, Inc.

Date: September, 1971

Project No. MISS-T9-2

Keywords: 1. Bus, intercity
2. Urban Development, planning
3. Surveys
4. Public Ownership
5. Ridership, volume
6. Financing Mass Transportation
7. Government, urban
8. Management, operations and techniques

Abstract: The report is a comprehensive technical study of mass transportation in a four-county area along the southern coast of Mississippi. This region, which includes the urban areas surrounding Gulfport, Biloxi, and Pascagoula, was served by private bus operations until 1969 when financial losses (caused in part by the destruction of Hurricane Camille) forced discontinuation. At that time a regional transit authority was established by the state legislature and provided with emergency operating subsidies to maintain a reduced service level. In May, 1971, the subsidy provision expired and the present study was undertaken to recommend methods by which the much-needed public transit system could be retained.

Existing transit in the Gulf Coast area is described with reference to operating characteristics, equipment, fare structure, management and personnel, financing, driver performance, maintenance, and a total breakdown of operating costs and other statistics. The operations serving Biloxi-Gulfport and Pascagoula are analyzed separately along with various intercity services, school busing, and service to the City of Picayune.

The authors conducted numerous surveys to determine ridership demand in the study area. These included on-board passenger surveys and questionnaires distributed among households, hospitals, and military bases. Available parking facilities are also examined. The report focuses particular attention on the regional transit authority with reference to legal status, jurisdiction over various transit systems, organization and management, franchise agreements, and temporary subsidy revenues.

These data were used to synthesize several recommendations for continued transit service in the four-county region. The authors suggest several new routes which will best serve present ridership demands; a five-year patronage forecast is also provided. The report notes particularly the demand generated by two proposed housing developments. The authors conclude that public transportation services are an essential part of the region's vitality which should be retained in the recommended corridors.

NTIS Order #: PB-207-406
PC \$3.00, MF 95¢

Index No. 2-MISS-2.1

Title; "Feasibility of Transit Service In Great Falls, Montana"

Authors: Simpson and Curtin, Transportation Engineers

Date: June, 1968

Proj. #: MONT-T9-1

Keywords: 1. Bus, intractiy 6. Traffic, congestion
2. Private Transportation, 7. Center City
automobile 8. Parking, capacity and demand
3. Routes and Routing 9. Elderly
4. Schedules and Scheduling 10. Youth
5. Headways

Abstract: The purpose of this study is to investigate the feasibility of transit service in Great Falls, Montana. The objective is to determine: (1) the need for transit operations, (2) the level of service required to provide an attractive system, and (3) the feasibility of providing transit service with public assistance.

The community decided nearly seven years ago that the private auto would be its primary means of transportation. Transportation planners now subscribe to a balanced transportation concept--one which provides alternate modes of travel in proportions that are desirable for, and can be supported by, the community. Continued reliance on the private automobile as the only means of transportation will require increasing expenditures for street improvements and parking facilities. The 1961 Transportation Study estimated an expenditure by Great Falls of nearly three million dollars for new streets by 1981.

The only public transportation alternative to the automobile is a bus transit system. It would provide a choice to those persons who must use an auto for their daily travels. To the extent that this choice is utilized, the demands for valuable downtown land for parking space and expenditures for streets and highways will be lessened. Because a bus is a much more efficient carrier of people, it provides some measure of relief from the traffic congestion which is becoming worse with each evening peak hour. Citizens with direct dependence upon public transportation--the elderly, the physically or mentally infirm, and youngsters between the ages of five and fifteen--constitute more than one-third of the city's total population. These groups, together with low income families and others who are unwilling to drive, represent an important segment of the city's population now deprived of mobility because of the absence of transit service.

Studies of traffic movements and one-way streets led to the selection and recommendation by the authors of one system of route patterns. This pattern, consisting of five routes, provides more direct service with the least interference from vehicular traffic and offers better service to schools, hospitals and other major traffic generators. All lines in the recommended route plan would radiate from the central business district, coordinating at the main terminal at Central Avenue and 2nd Street. Tentative schedules have been developed for these five routes with operations from 7:00 A.M. to midnight proposed for the Malmstrom AFB route and service from 7:00 A.M. to 6:30 P.M. on the other four lines. Buses would run at 30-minute intervals in the morning and evening peak periods, and hourly for the remainder of the day. The authors recommend a fare structure of 25¢ per adult fare, with a 15¢ charge for students and children.

NTIS Order #: PB-191-138
PC \$3.00, MF 95¢

Title: "Improved Transit Services" (Final Report)

Authors: Simpson & Curtin, Transportation Engineers

Date: October, 1970

Proj. #: NEB-T9-3

Keywords: 1. Public Ownership
2. Social Benefits and Costs
3. Government, urban
4. Management, planning and analysis
5. Benefit-Cost Analysis
6. Financing Mass Transportation, requirements

Abstract: This report presents a complete picture of the transit situation in Lincoln, Nebraska, and outlines a 16 point program for revitalization of transit service and restoration to the level needed to satisfy community needs. Lincoln City Lines is nearing the end of its existence as a private transit operation in Lincoln. Although the company cannot survive much longer under revenue-cost standards prevailing among privately owned utilities, there is still a substantial public need for bus transit in the city; the authors suggest public acquisition of the system, coupled with the capital necessary for improvements to restore operations to an attractive level of service.

Following acquisition, the city should invite proposals from management firms, as well as from experienced individuals who are interested in operating the transit system on a contract basis; depending upon the form of management which develops, the city should give consideration to consolidating the new transit activity either with other publicly owned utilities in a municipal utility department, or with traffic engineering in the public works department.

New facilities programmed for the first year of public operation should include: (a) 14 new 33-passenger coaches, (b) six bus shelters, (c) 200 new bus stop signs, (d) a two-way radio system connecting all buses to the central dispatcher's office, (e) major overhauls of 19 buses in the existing fleet, (f) rehabilitation of the garage, and (g) a new bus washer and Cyclone cleaner. Capital additions for the second to fifth year of municipal bus operations should include: (a) five new 33-passenger coaches, (b) six bus shelters, and (c) additional bus stop signs.

Throughout the analysis, primary attention to transit is concentrated on the City of Lincoln since the political subdivision embraces virtually all of the urbanized area within Lancaster County, and is the only area within which any present or prospective interest in transit can be sustained; some limited transit operations may extend beyond the city limits, but the principle focus will continue to be on service within the city. The significance of transit to downtown business and commercial development (by improving access from residential sections, increased downtown circulation, and supplementing downtown parking) should be emphasized, the authors recommend. Further, the downtown "Mini-Line" should be incorporated into the municipal transit operations, and additional transit services should include two new routes together with nine route extensions and revisions to the existing system.

The program is designed to shift emphasis on transit away from a failing private operation to a public service more responsive to the community's needs; under the proposed program, the financial question of whether each item will pay its own way would be subordinated to the potential public benefits flowing from the change. This is an important shift in emphasis which must be accomplished completely before any improvements can be seriously envisioned. The authors go on to suggest that a constant vigilance be maintained for opportunities to expand and improve transit service, even where such improvements may not be altogether justifiable from an economic standpoint.

NTIS Order #: PB-196-782
PC \$3.00, MF 95¢

Title: "Transit in Atlantic County"

Author: Simpson & Curtin, Transportation Engineers (for Atlantic County Improvement Authority)

Date: November, 1969

Project No. NJ-T9-3

Keywords: 1. Bus, intracity
2. Bus, jitney
3. Public Ownership
4. Financing Mass Transportation, requirements
5. Private Transportation, bus

Abstract: The report is a comprehensive technical study of public bus transportation in Atlantic County, N.J. Four private transit systems presently serve this area, but their operations are generally uncoordinated and Atlantic City Transportation Company, an essential link in the network, is currently sustained only by costly public subsidies due to characteristic financial difficulties. The purpose of this report was to review public transit operations in the Atlantic County area and to synthesize specific short and long-range recommendations for maintaining and improving the service.

The report briefly describes each of the bus systems which comprise the local network; these include three private companies and an association of private jitney owners. A detailed analysis of the Atlantic City Transportation Company reviews current operations (eg. service levels, loading standards, schedule adherence, speed of operation, directness of service, and fare structure); physical assets; and potential service improvements. The latter includes acquisition of new vehicles, construction of new garage facilities, increasing vehicle speeds, advertising and promotion, and service coordination.

Public participation in transit service is also examined with reference to various ownership and management options. The report focuses particular attention on revenue and cost estimates which would accrue from public operation of the system. Other alternatives include continued private operation, public operation at reduced levels of service, and jitneys.

Two major short-range recommendations are advanced to maintain continuity of service. These include provision of additional operating subsidies in combination with a drastic reduction of service and reappraisal of schedules and service currently operated by Public Service Coordinated Transport, another private company. Five long-range proposals include: (1) unification of areawide transit services; (2) broadened powers of the Atlantic County Improvement Authority; (3) replacement of some scheduled service with private jitneys; (4) operation of a publicly owned and operated transit system to replace the Atlantic City Transportation Company, should its services be discontinued; and (5) completion of the regional transportation plan.

NTIS Order #: PB-191-134
PC \$3.00, MF 95¢

Title: "Broome County Bus Transit Study: Evaluation, Analysis, and Recommendations"

Author: John E. Weinrich and Robert L. Gray (State University of New York at Binghamton)

Date: July, 1968

Proj. #: NY-T9-1

Keywords: 1. Public Ownership
2. Bus, priorities
3. Maintenance
4. Traffic, congestion
5. Traffic, flow
6. Parking, planning
7. Fares, cost determination
8. Fares, reduction
9. Freight Movement
10. Traffic, peak-hour

Abstract: The existing transit system in Broome County serves three separate business districts: Endicott, Binghamton, and Johnson City. Also served are: the Town of Union, which includes the Villages of Endicott and Johnson City; the Town of Vestal; and the Town of Dickinson. In addition to the transit service provided by the Triple Cities Traction Corporation, the Chenango Bridge Bus Lines operates service from downtown Binghamton to Chenango Bridge and Port Crane, and Schafer's Bus Lines operates local service in Endicott, West Endicott, and Vestal.

The authors recommend that Broome County take immediate steps to operate the transit system as a public enterprise; at the time of acquisition of the Triple Cities Traction Corporation franchise and selected facilities, the County should undertake a substantial modernization program. Included in the modernization would be acquisition of new buses, construction of a modern garage and servicing facility, the installation of new informational signs, and the construction of bus shelters at heavily patronized stops.

Extensive sales promotion, attractive service, passenger-oriented routing and scheduling, and social considerations should dominate the marketing of bus service in Broome County, in order to increase demand for bus service and to make it more inelastic than it is at present. Demonstration projects and experimental services appear to be required as means to generate or accommodate the demand for bus service. Consideration would be given to establishing priorities for buses during peak hours by using the arterial streets in congested major activity center areas in order to expedite bus service. Such priorities might consist of a ban on street parking, or the designation of one-way streets, or prohibition of turns by motor vehicles during peak hours, or a ban on truck loading and unloading along bus routes (Enforcement of a "No Parking" code in bus loading zones might also improve bus service time and lessen maintenance problems.). Consideration should also be given to offering short loop service between Binghamton center and nearby parking lots and garages in non-rush hours using buses which would otherwise be out of service; such service might have to be run with short headways and a low fare.

Fares should be increased for ordinary peak-hour runs, not only in acceptance of the fact that great inelasticity of demand prevails for bus service at such times, but also to permit the successful introduction of experimental discount fares for special groups (secondary and primary school children, Broome Tech students, university students, etc.).

The authors suggest that a carefully planned depreciation and maintenance schedule be adopted and rigidly enforced to ensure that the bus fleet is continuously modernized and to preclude the need in the future for the purchase of an entirely new fleet.

NTIS Order #: PB-191-207
PC \$3.00, MF 95¢

Title: "Nassau County Bus System, A Summary of Financial Aspects:
Technical Report #2"

Author: Nassau County Planning Commission

Date: October, 1968

Proj. #: NY-T9-2

Keywords:	1. Bus, costs	4. Ridership, volume
	2. Financing Mass Transportation	5. Maintenance, facilities
	3. Fares, cost determination	6. Information Aids

Abstract: The purpose of this report is to present the financial aspects of bus transportation in Nassau County. It presents the revenue and cost factors pertaining to operations.

Drivers and mechanics in all of the companies with the exception of Branch, Jerusalem Avenue, and Roosevelt are under union contract. The spread of the existing contracts runs from a high of \$3.45/hour for Schenck to a low of \$2.86/hour for Stage Coach and Universal. The wage rate in the non-union companies is considerably lower with hourly rates as low as \$2.00. Whereas the major companies are all grouped at the top end of the wage spectrum, the minor companies are at the other end. With labor costs running approximately two-thirds of operating costs, it can easily be seen that this is the controlling factor in any bus operation.

Over the past five years, operating revenues for Bee Line, Inc., the largest system studied, have risen only slightly. This can be accounted for by increased fares as the yearly total of passengers carried decreased by over two million. One of the largest items of cost increase has been transportation expense, which has risen by almost twenty-five percent. Net income has great variance, fluctuating from \$107,794 in 1965 to \$18,023 in 1966. This past year a modest return of \$11,601 was realized. Charter operations account for a very minor portion of the total revenues. A very stable financial picture is shown with the major fluctuations attributable to strikes.

Within the existing fiscal arrangements that presently exist much can be done that would provide savings in many areas of bus operations. Notable among areas which merit further consideration are the following: (1) centralized purchase of parts, fuel and tires; (2) specialized maintenance facilities such as bus washing machines; (3) centralized paint shops; and (4) grouping of information services and advertising.

NTIS Order #: PB-191-140
PC \$3.00, MF 95¢

Title: "Nassau County Bus System, Prospects for Bus Transportation: Report #3"

Author: Nassau County Planning Commission

Date: October, 1969

Proj. #: NY-T9-2

Keywords:	1. Ridership, attraction	5. Demand-Responsive Systems
	2. Traffic, peak-hour	6. Schedules and Scheduling
	3. Information Aids	7. Routes and Routing
	4. Bus, stations and shelters	8. People Movers, Alden StaRRcar

Abstract: This report completes the final phase in the evaluation and analysis of bus transit in Nassau County. The problems have been described and goals have been formulated. Transportation in Nassau County has reached a major turning point. Most major arterials in Nassau are presently at their design saturation levels, with a number already having exceeded these levels. Travel time between points in Nassau is increasing despite highway improvements. The only feasible solution to Nassau's transportation problems which can be implemented right now seems to be a restructuring of the existing system coupled with an intensive reeducation of public attitudes.

Short term programs initiated to increase bus transit ridership should emphasize comfort and convenience. In order for the transportation modal split to shift from an almost one-hundred percent dependence on the private automobile to a greater apportionment to transit riding, substantial effort in these areas will be required. Analysis of a typical bus journey has shown that there are considerable difficulties in securing proper information with regard to routes, schedules and service. Coupled with the deficiencies in information dissemination is the inconvenience of waiting at exposed bus stops in all types of weather conditions. In response to these two situations preliminary studies have been conducted on the provision of bus shelters and a central county-wide transportation information system by the County Planning Commission.

A possible long range proposal for providing improved bus service in a low density area such as Nassau County is the concept of demand bus service. Currently it is not economically feasible to route and schedule present transit vehicles efficiently when only a few people want to go to and from the same places during a short period of time. In response to this problem a concept of demand bus service, "Dial-A-Bus" or a demand activated bus system has been developed. A demand bus service has the inherent advantage of being able to do what no other transit system now does, handle door-to-door travel demand at the time of the demand. This means that the system would attract more off-peak business than does conventional transit. And if it attracts enough passengers, the off-peak revenue would help "Dial-A-Bus" avoid the same financial problems of conventional transit, which is used heavily only 3 or 4 hours per day. It would also help reduce the almost total dependence on automobiles. Other long range transportation proposals being considered are the minirail, the People Mover, and the Alden StaRRcar.

NTIS Order #: PB-191-141
PC \$3.00, MF 95¢

Title: "Job Accessibility: A Study of Factors Inhibiting Employment"

Author: Syracuse - Onondaga County Planning Agency

Date: September, 1969

Proj. #: NY-T9-3

Keywords: 1. Urban Development, renewal 6. Private Transportation, automobile
2. Center City 7. Routes and Routing
3. Inner-City 8. Time Cost
4. Employment 9. Surveys
5. Demography 10. Race

Abstract: This report focuses on the job opportunities afforded the residents of Syracuse's Model Cities Neighborhood (bordering on the southwest of the central business district) from the aspects of accessibility to public transit and other factors which might have been inhibiting employment of the residents.

Step one of this study's methodology was the selection of family income as the criterion identifying those persons for whom the most attention was needed. Maps of location are presented disclosing the sections of Syracuse where families earning \$3,000 or less reside. The second step was to consider the results of approximately 1,200 interviews conducted to discover concepts of "the unemployment issue". One of the more interesting results of the survey tabulation was of a group of "other males" of at least high school age (but not in school), who had not reported disability and were not retired, but were reported as higher-employed not looking for work. The significant factor is that for various reasons these men have been effectively barred from joining the workforce. "Other males" number some 1,400 persons.

This report is presented in four parts: (1) Significant characteristics -- a specification of the factors potentially relating to employment, including estimates of magnitudes; (2) Problem Areas -- an analysis of both the relationships among these factors and their influence on the employment situation in Syracuse, toward the identification of employment inhibitors; (3) Potential Solutions -- a presentation and evaluation of proposed solutions to the problems and recommendations of specific action programs; and (4) Technical appendix -- a discussion of the methodologies applied in the conduct of the project, presented with exhibits and commentaries on the effectiveness of experimental techniques utilized.

The report observes that an estimated 18,000 jobs are not served by the public transit system at all. Also it is shown that the public transit system is only about 1/3 as efficient as the auto in providing inner-city residents with access to job opportunities. Consequently, the unemployment rate is almost 10 times higher for persons dependent upon the bus for work-related travel than among auto users. Currently available public transit resources are unable to correct these problems without incurring crippling financial loss.

NTIS Order #: PB-193-007
PC \$3.00, MF 95¢

Title: "Niagara Frontier Mass Transit Study -- Summary Report"

Author: Niagara Frontier Transportation Authority

Date: September, 1971

Project No. NY-T9-4

Keywords: 1. Urban Development, planning
2. Rail, systems planning and design
3. Rail, automatic control
4. Rail, rolling stock
5. Rail, stations and terminals
6. Rail, cost
7. Environment and Environmental Control
8. Bus, busways
9. People Mover, monorail

Abstract: The report summarizes a comprehensive technical study of rapid transit for the Buffalo-Amherst corridor. All relevant data are contained in the introductory text with reference to demographic characteristics of the study area and project history. The study was conducted in four general phases which covered: (1) collection and evaluation of the data, (2) selection of the vehicle and guideway systems to be used, (3) testing of alternative alignments and system configurations, and (4) determination of technical and economic feasibility.

Phase One activities included an inventory of the eleven regional bus companies, a modal-split analysis of existing ridership, an attitude survey of area households, travel-time checks and a parking survey, predicted future land use studies, and generation of service standards. Operational criteria for future services were developed with reference to routing, service frequency, loading factors, headways, station spacing, vehicle speed, transfer time, and fares. In addition, the report estimates a likely regional highway network for 1975.

Data collected during Phase One became inputs to a computer program which generated 23 alternative segmental links for the proposed rapid transit line. These were examined with reference to their impact on seven urban design factors and seven service quality features. The analysis yielded three alternative alignments which were then subjected to a rigorous testing against nine basic variables, including environmental impact, property acquisition, service potential, proximity to major trip generators, engineering constraints, development opportunities, estimated construction costs, impact on existing neighborhoods, and adaptability to feeder bus and park-and-ride facilities.

More than 200 modes of urban transport were catalogued and screened in a pre-selection process wherein each proposed system was rated according to five general requirements. These included: (1) minimum service parameters, (2) peak-hour capacities of 20,000 passengers, (3) fail-safe automatic controls, (4) cost, and (5) feasibility within state-of-the-art. Eight specific systems were selected for further analysis; these included variations of paved roadway (eg. busways), contact-guide (eg. railway), and monorailway modes. Each system was rated according to its respective service potential, design characteristics, environmental impact, operational performance, and cost. The authors conclude that a conventional heavy volume, steel wheel duorail will best satisfy transit requirements in the corridor.

Specific recommendations for the regional bus network are outlined along with structural specifications for the rapid transit guideways and stations. Costs and benefits of the proposed seven-year implementation program are also considered. The report contains photographs of the recommended transit route and other pertinent illustrations.

NTIS Order #: PB-208-524
PC \$3.00, MF 95¢

Index No. 2-NY-4.8

217

Title: "Niagara Frontier Mass Transit Study: Technical Report"

Author: W.C. Gilman & Company, TEI Consulting Engineers, and Wilbur Smith & Associates

Date: September, 1971

Project No. NY-T9-4

Keywords:

1. Urban Development, planning	6. Corridors
2. Rail, systems planning and design	7. Structural Analysis
3. Rail, cost	8. Construction, cost
4. Financing Mass Transportation, requirements	9. Demography
5. Management	10. Ridership, volume
	11. Modal Split

Abstract: The report presents supplementary technical data to the Niagara Frontier Mass Transit Study. Three private contractors prepared individual analyses of transit economics, civil engineering, and traffic engineering as parts of the comprehensive research effort.

With reference to transit economics, the authors examine existing public transportation in the region and review recent operating trends. The evaluation of present service underscores the need for a unified, coordinated transit system under the jurisdiction of a regional authority. Alternative management options are reviewed in detail along with the effects of a unified regional bus transit network on various aspects of the metropolitan area. The section concludes with a brief discussion of implementation requirements.

The civil engineering study concentrated upon construction requirements for the proposed expressways and rapid transit facilities. The latter will be designed to serve specific high-density demand corridors which are described in detail. The analysis examines mode selection, alternative alignments, station site selection, engineering and architectural constraints, a testing program, and the final recommended scheme. In addition, the authors review projected social and environmental benefits. Costs and timescale associated with the recommended implementation program are also discussed.

The traffic engineering section examines present and future land use, demography, and travel demand. Data from several regional surveys are reviewed along with forecasts of selected regional variables for the year 1995. The report also examines and applies various modal split and travel forecasting models to estimate demands on the proposed system. These data were also used to evaluate alternative rapid transit configurations; the recommended plan is outlined in detail with reference to service standards, alignment and stations, feeder bus interfaces, projected ridership, peak-hour demands, travel impacts, and effects upon area highway travel. The report concludes with a discussion of estimated operating results which were calculated on the basis of cost and patronage forecasts.

NTIS Order #: PB-210-686
PC \$6.00, MF 95¢

Title: "Transit Facilities and Operations -- Volume I: Maintenance Facilities"

Author: Simpson & Curtin, Transportation Engineers

Date: July, 1970

Project No. NY-T9-5

Keywords: 1. Maintenance, facilities
2. Maintenance, costs
3. Routes and Routing
4. Site Selection
5. Land, acquisition
6. Depreciation
7. Relocation
8. Quantitative Analysis
9. Land Use

Abstract: This report is one of three documents generated by an overall technical study of the Utica, New York, transit system. The report focuses on the existing complex of maintenance facilities, located strategically in an industrial area with good access to the city's major arterial routes. Two factors necessitated the study: First, construction on a nearby expressway will block several transit routes, eliminate one access to the maintenance facility, and reduce the size of the property by some 3,600 square feet. Second, the physical plant is deteriorated; one building has already been condemned and another will require extensive renovation to meet state safety standards.

The report analyzes location of the facilities both in terms of their viability during the expressway construction and their possible relocation elsewhere in the Utica area. To determine optimal location, the authors calculated a theoretical "center of gravity" for all bus routes in the city to plot an ideal location for the base of operations. The analysis revealed that the present location, only four blocks from the estimated center of gravity, is unusually well-situated, accounting for the system's extremely favorable ratio of non-revenue miles logged. Alternative calculations were made, treating morning outbound and evening inbound runs as deadhead mileage. These computations yielded a different center of gravity, but one which was located in the midst of a residential housing zone unsuitable for relocation of the bus facilities. The authors recommend retention of the existing site. Additional factors involving real estate costs, sale of the present property, and the actual relocation are also discussed.

The report also analyzes the existing physical plant. Requirements for storage, maintenance, control and dispatching, and management functions are listed and compared with the present structures. Building descriptions are supplemented with graphic diagrams and photographs. Provision for the flow of vehicles is also discussed, especially where physical barriers restrict the optimal movement of buses through the maintenance complex. Specific problem areas created by the expressway construction and general deterioration of the buildings are outlined. The authors also synthesize a number of specific recommendations which are described along with estimated costs for all remodeling and reconstruction.

NTIS Order #: PB-197-950
PC \$3.00, MF 95¢

Title: "Transit Facilities and Operations -- Volume II: Routes and Service"

Authors: Simpson and Curtin

Date: October, 1970

Proj. #: NY-T9-5

Keywords: 1. Routes and Routing
2. Ridership, volume
3. Traffic, peak-hour
4. Schedules and Scheduling
5. Demography
6. Bus, costs
7. Financing Mass Transportation, requirements

Abstract: The purpose of this report is to present the results of an in-depth analysis of the bus routes operated by the Utica Transit Commission.

This analysis involved many tasks. The first was a review of all available data on riding of the individual routes, transfer patterns, and peaking characteristics. A second area of review was an analysis of the financial performance of each route. To accomplish this, system operating costs are broken down into individual components, and these components are assigned to the independent variable to which each is most closely related. Another essential element in the analysis is personal observation, by riding the buses. This fills in the inevitable gaps in understanding left by the straight-forward collection of data, and gives meaning to the numbers. Finally, the transit routes must be related to the community needs. This calls for a review of population and demographic data, and patterns of urban development. These data can then be assembled in the form of "route profiles" showing the essential characteristics of each route. Design of route changes can then proceed, with the object of providing coverage of the area, reducing the need for transfers, arranging schedules to suit demand, and minimizing the need for vehicles and manpower.

Weekday bus service in Utica is operated over 15 routes. On two of these routes, 25 Sunset Avenue and 27 Lincoln Avenue, only rush hour service is operated, while on 10 routes, service is discontinued after the afternoon peak period. A total of 28 buses is required during the morning peak, while an additional four buses are used in the afternoon for a total of 32 units, the maximum needed for daily route operations.

To maintain an equitable balance between public need and realistic financial performance, study and concern must be given to means of reducing operating costs without drastically affecting revenues. To accomplish this goal, the authors recommend the consolidation of routes in areas where overlapping or more than adequate service appears to be offered. A review of the present routes of the system seems to indicate several areas where route consolidation should be considered. Another means of reducing operating costs is by adjusting service frequencies on present routes where it appears justified, coupled with the elimination of excessive layover time. The operating schedules of a majority of the routes operated by the Commission have been prepared to allow several routes to operate in combination by means of through-routing one bus on three routes.

NTIS Order #: PB-197-951
PC \$3.00, MF 95¢

Title: "Transit Facilities and Operations --Volume 3: Transportation Center"

Author: Simpson & Curtin, Transportation Engineers (for City of Utica)

Date: November, 1970

Proj. #: NY-T9-5

Keywords: 1. Interface
2. Intermodal Competition
3. Bus, Intercity
4. Bus, Stations and Shelters
5. Rail, Stations and Terminals
6. Parking, Facilities
7. Private Transportation, Bus

Abstract: The report examines the requirements for and the feasibility of designing a "transportation terminal" for downtown Utica, New York. Its primary function would be as a point for modal interface at which the variety of transit operations serving Utica could be coordinated, providing easy transfer between modes. The need for a transportation terminal is discussed at length, and supported by several factors. First, there is not presently an adequate coordination among the intercity bus and rail carriers which serve Utica and the City's public transportation systems. Second, the terminal for the primary mode of intercity public transportation, the motor coach, is inadequate and deteriorated. The railroad station, however, is completely adequate, but under-utilized. The authors conclude that joint use of the railroad station by the railroad, the City's three intercity bus carriers, and the transit system, with supporting taxi service and adequate automobile parking, should be made.

The report analyzes several criteria for establishing such a transportation center. Location of the facility is emphasized so as to provide access for passengers, carriers, and the local transit system, and to minimize the distance from major arteries. The report also outlines necessary facilities within the center, with specifications tailored to the projected demand for each mode. Additional requirements for ticket counters, rest rooms, baggage handling, information services, parking, and a taxi stand are examined briefly.

The report also evaluates the City's two existing transportation terminals (Utica Bus Terminal and the Penn Central Railroad Station) in terms of the criteria for a viable transportation center. Although the bus station enjoys central location in the Utica business district, the physical plant is badly deteriorated and necessary expansion to accommodate additional services is impractical. The railroad terminal, however, was found to be capable of substantially greater utilization and expansion, and easily adapted to contain intercity bus operations.

The authors' recommendations are detailed in terms of converting the railroad terminal into a multi-modal transportation center. Current train service through the terminal is outlined, along with necessary physical remodeling. Traffic flow around the station when adapted for bus use is diagrammed. The recommendations also emphasize initial steps in creation of the transportation center which include negotiations among the transit carriers and exploration of funding alternatives.

NTIS Order #: PB-197-952
PC \$3.00, MF 95¢

Title: "Charlotte-Mecklenburg Public Transportation Study: Short Range Transit Needs -- Phase I"

Author: Wilbur Smith and Associates, Inc.

Date: September, 1971

Project No. NC-T9-2

Keywords: 1. Bus, intracity
2. Bus, transfers
3. Bus, priorities
4. Ridership, profiles
5. Surveys
6. Fare, cost determination
7. Advertising and Promotion
8. Routes and Routing
9. Information Aids
10. Safety
11. Center City
12. Age

Abstract: The report is a comprehensive technical study of bus transit operations in the Charlotte-Mecklenburg County metropolitan area. Its purpose was to summarize and evaluate existing public transportation services and to synthesize a recommended short-range improvements program.

Intracity bus transit is presently operated by a private carrier; an inventory of existing facilities is provided with reference to route configuration, areal coverage, location of stops, equipment, and organization and personnel. Current operations are summarized in detail, including hours of service, headways, schedule adherence, equipment utilization, load factors, average speeds, transfers, financial statement, operating franchise, and valuation.

A study of passenger trends revealed a continuous decline in transit patronage, although miles operated have remained relatively constant. The authors conclude that attempts to gain additional ridership through increased route coverage have been unsuccessful. The total decrease in patronage, however, has been only about 9% since 1961, thus indicating some stability among the user group. A survey of passenger characteristics yielded a basic customer profile; 90% of all riders are within the normal age expected to drive cars, 80% are female, and work trips were found to generate more than 2/3 of total demand volume. Significantly, the survey indicated that 95% of all passengers were regular transit users, and that 76% rode the bus four or more times per week. Additional surveys were conducted to examine public attitudes towards transit and the relative availability of automobiles per household. All relevant data are included in the report.

Policy considerations are discussed in detail as a basic guide for developing short-range improvements. The public role in urban transportation is examined along with financial projections of the present company. The authors recommend creation of a public transportation authority to coordinate future multi-modal developments in the Charlotte-Mecklenburg County region.

Specific short-range improvements are outlined with reference to fare modifications, marketing, safety features, rider amenities, schedule and route changes, and special operations in the central business district. The authors recommend a general fare increase to balance rising costs; mobile control units and bus alarms are also proposed as means of improving fleet supervision and public safety. Nineteen specific route changes are also proposed. For downtown service, the report recommends route changes, exclusive bus lanes and other priority measures, and loop service. The report contains all relevant statistical material and maps illustrating proposed route coverage.

NTIS Order #: PB-208-532
PC \$3.00, MF 95¢

Title: "Winston-Salem Transit Study"

Author: Wilbur Smith and Associates

Date: October, 1971

Project No. NC-T9-3

Keywords: 1. Public Ownership
2. Financing Mass Transportation
3. Management, planning and analysis
4. Management, operations and techniques
5. Ridership, volume
6. Surveys

Abstract: The report is a comprehensive technical study of urban mass transportation in the Winston-Salem metropolitan area. A general description of regional demographic and land use patterns is provided in the introductory text along with a brief history of local transit and recent patronage trends. Since 1968, bus transit has been operated by a private carrier -- Safe Bus, Inc. -- under a franchise agreement with the Winston-Salem Transit Authority. Recent declines in ridership (48% in five years), coupled with rising costs, have threatened to force discontinuance of the present service. The purpose of this report was to examine existing regional public transportation in detail and to synthesize a recommended improvements program.

All relevant aspects of the current operation are summarized, including: (1) ridership trends, (2) financial results and assistance, (3) cash flow deficiency, (4) routes and coverage, (5) fares, and (6) equipment and facilities. Several surveys were conducted among transit passengers to determine a ridership profile, regional travel patterns, and equipment requirements. Results of the on-bus survey are broken down with reference to trip purpose, car ownership, family size and income, employment status, age and sex, frequency of transit use, and weekend transit use. The report also identifies demand volumes both within and outside the central business district.

The report contains a comprehensive inventory and valuation of all property currently owned by the local carrier. The inventory included all buses, service vehicles, shop tools and equipment, land and buildings, materials and supplies, and other general property.

The principal recommendation advanced in the report is for acquisition of the private company by the metropolitan transit authority. Actual operation of the bus system would be performed under a management contract. Specific proposals are also noted with reference to equipment and facilities improvement, organization and administration, and provision of franchise rights; a five-year projection of revenue and expense estimates is included. A two-phase implementation program is suggested to effect immediate service changes and coordinate long-term improvements following acquisition of new equipment and facilities. A wide variety of financing alternatives are explored; the report notes that the proposed system will be dependent upon public resources to sustain operations. Appended material includes a financial statement of Safe Bus, Inc.; appropriate local ordinances; and a suggested form of management agreement.

NTIS Order #: PB-208-506
PC \$3.00, MF 95¢

Title: "Toledo Transit Analysis"

Author: W.C. Gilman & Company

Date: February, 1970

Project No. OHIO-T9-2

Keywords: 1. Bus, intracity
2. Surveys
3. Ridership, volume
4. Management, planning and analysis
5. Public Ownership

Abstract: The report is a comprehensive technical study of bus transit in Toledo, Ohio. The existing, privately-owned system is characterized by declining patronage and rising costs which cannot be met through farebox revenues. The purpose of this report was to examine all relevant aspects of the Toledo bus system and to recommend specific alternatives for improving service.

Current operations are analyzed with reference to revenues, expenses, vehicle miles, vehicle requirements, employees, and ridership. The report also examines each of the three private companies which were consolidated in 1969 to create the present transit system. The report also discusses the present labor contract, employee pension program, and franchise ordinance.

Ridership characteristics were determined in a passenger survey which identified frequency of bus use, captive rider groups, trip purposes, modes used to reach bus stops, and general public opinions about transit. Origin-destination data were employed in a comprehensive route analysis which identified potential express corridors and circulation requirements in the central business district.

The authors focus particular attention on alternative transit operations for the future. These include: (1) retention of the existing system, (2) increased service designed to improve the quality of public transit, and (3) efforts designed to maintain current patronage levels. The report also examines projected operating costs and the advantages of public ownership of the transit system.

The authors conclude that for economic reasons, the third alternative (maintenance of current patronage) should be adopted. The recommended program stresses the acquisition of new rolling stock and other capital improvements. The report also recommends the creation of a regional transit authority to purchase and operate the Toledo bus system.

NTIS Order #: PB-210-700
PC \$10.25, MF 95¢

Title: "Transportation Study -- A Part of the Mass Transportation Program for East Liverpool and Environs"

Author: Carroll V. Hill & Associates (for City of East Liverpool, Ohio)

Date: January, 1971

Proj. #: OHIO-T9-3

Keywords: 1. Bus, intracity
2. Bus, cost
3. Bus, school bus
4. Ridership, profiles
5. Trip Generation
6. Financing Mass Transportation, requirements

7. Fare, cost determination
8. Modal Split
9. Routes and Routing
10. Schedules and Scheduling
11. Surveys
12. Freight Movement

Abstract: The report covers a detailed technical study of mass transportation in East Liverpool, Ohio. The existing topography is characterized by an urban network of radial streets which lack sufficient crosstown linkages thus creating an undesirable concentration of traffic movement in the central business district. The basic objective of the report was to analyze all aspects of the present system and to synthesize recommendations for improvement.

Local population characteristics and trip generators are identified briefly. Existing bus service is examined with reference to routes, equipment and maintenance, fare structure, current ridership, revenues, and operating costs. The system is characterized by a common profile of declining patronage and rising costs which cannot be met by farebox revenues. In addition, the report examines ancillary transit operations including limousine, school bus, taxi, and ambulance services. The report also documents results of several group transportation surveys conducted among the current passengers and randomly selected households. The surveys cover all relevant aspects of trip generation, modal split, and other travel characteristics.

These data were used to synthesize four alternative proposals for transit improvement, emphasizing a new routing network designed to conform with ridership demand and projected trip patterns. Each alternative routing configuration is outlined in detail along with recommended schedules. The responsiveness of each to trip generation, distribution, and modal split characteristics is discussed as the basic evaluative criterion for implementation. The recommended mass transit plan is then examined. The authors also discuss the feasibility of instituting customized bus operations to serve major trip generators as well as for parcel delivery. Consolidation of school bus services with the public transit network is not recommended. The report concludes with brief criteria for vehicle selection, a projected vehicle utilization schedule, an optimal fare structure, and cost breakdowns for implementing the recommended program. Financing alternatives for overall transit operations are discussed briefly.

Appended material includes reproductions of the survey instruments, detailed bus route information, and tabular results of transportation surveys and alternate network studies.

NTIS Order #: PB-204-064
PC \$3.00, MF 95¢

Title: "Interim Transit Study (Final Report)"

Author: Montgomery and Greene County Transportation and Development Planning Program

Date: September 7, 1970

Project No. OHIO-T9-5

Keywords: 1. Financing Mass Transportation, sources 5. Government, county
2. Management, operations and techniques 6. Government, urban
3. Management, planning and analysis 7. Government, Federal
4. Bus, cost 8. Social Benefits and Costs

Abstract: The report is a comprehensive technical study of mass transportation in the Ohio counties of Montgomery and Greene (which include the City of Dayton). The area is presently served by a network of bus operations that reflects a characteristic profile of rising costs and declining patronage. These factors threaten curtailment of all service now provided by the City Transit Company, a major component of the existing system which operates presently under a franchise agreement with the City. As a result, two immediate objectives of the County Transportation and Development Planning Program were established. These include: (1) preservation and maintenance of the existing transit system at current levels of service, and (2) development of administrative and financial capabilities to upgrade and improve the future system. This report was prepared to provide quantitative and qualitative data, evaluate the existing administrative structure, and to synthesize recommendations within the parameters of the two basic objectives.

The report examines current transportation in the two counties with reference to operating companies, service levels, routes and scheduling, load factors, suburban service, equipment condition, passenger and service trends, fare structure, maintenance facilities, operating costs, revenues, marketing and advertising, and labor agreements. Several problems were identified in this analysis including poor continuity among the operations of different transit lines, inadequate funds, obsolete equipment and rolling stock, automatic fare increases to cover rising costs, inflexible regulation by the Public Utilities Commission, under-capitalization and minimal capital reinvestment, lack of public involvement in transportation planning, imbalance in public investments between highways and transit, and failure to regard transit as a necessary public service.

The authors weigh various problems and alternative solutions in four basic categories: (1) administrative, (2) financial, (3) legislative, and (4) community benefits. The report recommends creation of a regional management authority to improve coordination among different components of the overall system. Cost estimates for future operations are examined under the financial category; the authors recommend immediate participation in relevant Federal grant programs. Existing legislative and jurisdictional regulations are examined in detail. The report recommends reorganization of the Miami Valley Regional Transportation Authority to permit the undertaking of capital improvement programs and utilization of fiscal powers granted in the enabling legislation. Community benefits are discussed with reference to direct user benefits (ie. mobility for transit captives) and improvements in traffic congestion, air pollution, public safety, and the area tax base. A detailed improvements program and implementation plan is outlined along with potential sources of funding.

NTIS Order #: PB-207-281
PC \$3.00, MF 95¢

Title: "Technical Study of Mass Transit Facilities in Mahoning and Trumbull Counties"

Authors: Stone & Webster Management Consultants, Inc.

Date: July, 1971

Proj. #: OHIO-T9-6

Keywords: 1. Ridership, volume
2. Public Ownership
3. Bus, school bus
4. Management, planning and analysis
5. Government, Federal
6. Financing Mass Transportation, requirements

Abstract: The purpose of this study is to analyze the existing transit facilities in Mahoning and Trumbull Counties to determine the economic and operational feasibility of consolidation and integration. The scope of the study encompassed some 37 separate bus lines, broken down into three main systems, the Youngstown System, the Warren System and 35 separate school bus systems.

The use of public transportation in Youngstown has followed the same pattern of other transit systems throughout the United States in the years following World War II. The American's love for the automobile combined with the out-migration from the center city to the suburbs has provided a drastic reduction in passengers while expenses and the cost of new equipment have steadily increased. Revenue passengers for the Youngstown system decreased 73% from 8.6 million per year in 1960 to 2.3 million in 1969. The ridership in 1970 is estimated to decline to 1.9 million passengers and miles operated will decline to 1,218,000 due to curtailment of Sunday and Holiday service. On August 8, 1970, the Youngstown Transit Company ceased operations. The Mahoning Valley Regional Mass Transit Authority assumed the operations as of August 10, 1970, by entering into an agreement to lease all rolling stock, garage, and maintenance facilities from the Youngstown Transit Company for an initial three-month period with an option to extend the lease agreement for an additional month at a fee of \$7,250 per month.

Thirty-three of the thirty-five school districts in Mahoning and Trumbull Counties own and operate school buses. Six also employ school bus contractors to transport some of their pupils. The other two districts, Niles and Girard, rely entirely on a contract bus operator to transport their pupils, but will probably terminate contract operations and operate their own buses starting in the 1971-72 school year. The size of the school bus fleets varies greatly from district to district. As of the end of the 1969-70 school year, Austintown had the largest fleet of district-owned buses in the two counties: forty-nine, not including spare buses. In addition they employed a bus contractor to transport some of their pupils. Few school districts in the two counties have adequate management for their school bus fleets. Only five districts have full-time school bus managers or supervisors. In most districts, a teacher, school administrator, mechanic or other district employee has the responsibility for school bus activities as part of his duties; most frequently, it is the district superintendent.

The authors recommend the formation of a transit authority, obtaining financial assistance for new equipment from the Federal Government, improving the service, and integrating the 35 school bus systems into the agency. A technically competent, aggressive manager should be hired to implement the program and handle the daily management of the Authority. Standing and temporary committees should be formed within the Transit Authority to analyze and report findings and assist in the implementation of the program.

NTIS Order #: PB-204-057
PC \$3.00, MF 95¢

Title: "Eugene-Springfield Transit Study Report"

Author: Alan M. Voorhees & Associates, Inc.

Date: December, 1969

Proj. #: ORE-T9-1

Keywords: 1. Government, urban
2. Public Ownership
3. Bus, cost
4. Demography
5. Financing Mass Transportation, requirements

6. Routes and Routing
7. Bus, stations and shelters
8. Communications
9. Fare, collection
10. Management, training techniques
11. Management, operations and techniques

Abstract: The study analyzes existing bus transit services and defines future needs in the Eugene-Springfield area of Lane County, Oregon. The report identifies possible roles for local governments in meeting the problem, including financial, organizational and administrative alternatives.

The area is currently served by the Emerald Transportation System, Inc. (ETS), a small, privately owned bus system which has recently reached the point where it can no longer be expected to earn any operating surplus. The present system cannot long survive and there are no prospects that any private operator would be interested in providing service without public financial assistance. The system carries approximately 2200 passengers each weekday (1965 survey data) with only the very minimum offered in standards of service.

The report states that due to the expected growth in the urban area, increased university-college activities, and new industries, more people are interested in supporting local government financial aid for the ETS to establish a more adequate municipal transit department.

The report proposes an improvement program which contains the following key actions for a new system to be developed in a logical sequence during the 1970's: (1) public acquisition of the assets of the present company; (2) acquisition of a modern vehicle fleet; (3) building and equipping of a new bus garage; (4) restructuring of routes and expansion of service; (5) marking of bus stops and provision of management and staff training; (7) development and promotion of a new transit image; (8) planning and demonstration of new services; and (9) addition of new equipment - fare boxes, radios, etc.

Financial prospects are reviewed, and the first and second years' operating costs and earned revenues are estimated. It is concluded that there is sufficient riding potential to make it possible to approach a break-even situation. The report proposes that the creation of a public authority will best suit the area needs.

NTIS Order #: PB-191-132
PC \$3.00, MF 95¢

Title: "Portland Mass Transit Study -- Phase I-A: Municipal Acquisition"
Authors: Edmundson, Kochendoerfer, Kennedy/Daniel, Mann, Johnson & Mendenhall
Date: July, 1969 Proj. #: ORE-T9-2

Keywords: 1. Public Ownership 6. Social Benefits and Costs
2. Fare, cost determination 7. Management, operations and techniques
3. Bus, cost 8. Management, planning and analysis
4. Government, urban 9. Financing Mass Transportation,
5. Government, taxation sources

Abstract: The report is a detailed proposal for municipal acquisition of transit services in the City of Portland, Oregon. Until 1968, public transportation was operated by a private bus carrier whose petition for substantial fare increases precipitated the acquisition as provided for by clauses in the company's franchise. The purpose of the report is to detail management, financial, legal, and procedural recommendations for completing the transfer of bus services from private to public ownership.

Several basic criteria for managerial operations were developed and employed in an evaluation of six possible alternatives. These included: (1) city operation through a transit bureau, (2) city ownership with contract management, (3) creation of a Transit Commission by statute, (4) creation of a Transit Commission by charter amendment, (5) city ownership with non-profit transit corporation operation, and (6) city ownership with non-profit corporation leasing. Each possible management system is examined in detail along with relevant administrative flow charts. The authors recommend immediate statutory creation of a transit commission empowered to lease bus equipment and facilities to a non-profit transit corporation. Long-range municipal operation would then be undertaken by a regional transit authority to be established by amendment to the City Charter. An internal administrative organization is also proposed.

Immediate implications of acquisition are described with reference to plant and equipment, assumption of outstanding contractual obligations, requisite legal procedures and documentation, and institution of short-term facilities and service improvement programs. The authors calculate that a cash working fund of at least \$200,000 will be necessary. A detailed inventory of proposed capital improvements and related costs is also outlined; service changes include revision of the fare structure and creation of a new "image".

Financial aspects of acquisition are examined at length. The report explores alternative levels of operation to be achieved during the first years of municipal ownership. These include various combinations of previous service and fares. Commensurate levels of capital funding and subsidization are also computed. Seven sources of potential revenue are identified, including: (1) bond issues with general tax support, (2) a ten-year tax levy, (3) increased property taxation, (4) sales taxes, (5) personal income taxation, (6) a "readiness to serve" household tax, and (7) increases in license fees and other municipal income sources.

An extensive cost-benefit analysis of proposed management and service alternatives is recommended. The authors conclude that substantial social benefits are generated by a public transit system which warrant a sharing of the financial burden among both users and non-users in the community.

NTIS Order #: PB-203-800
PC \$3.00, MF 95¢

Title: "Lancaster Mass Transit Study"

Author: Wilbur Smith and Associates

Date: December, 1969

Proj. #: PA-T9-3

Keywords:	1. Private Transportation	4. Private Transportation, bus
	2. Government, urban	5. Management
	3. Financing Mass Transportation, requirements	6. Bi-Modal Systems

Abstract: This report contains the results of extensive field studies undertaken in the City and County of Lancaster to identify existing and anticipated public transportation needs and priorities, and to recommend a program for future ownership and operation of Lancaster's transit system.

The findings of this study indicate that the continuation and improvement of public transportation in Lancaster should be accomplished through preservation of private ownership and through public subsidy of all or part of the fixed-route operating losses of Conestoga Transportation Company (C.T.C.). In addition, Lancaster County and City should combine their resources to improve effective utilization of public transportation service.

The authors recommend that the city and county jointly establish a bus transit commission or authority to regulate and assist the private operator(s) in various matters, including: (a) bus stop locations and markings; (b) fares and transfer privileges; (c) routings; (d) scheduling; (e) financing of improvements and capital equipment, including the participation in relevant local, state, and Federal assistance programs; (f) provision of subsidy, as required; (g) final determination of methods for accounting checks which would be required in the event of subsidy payments; (h) promotion of shop-and-ride and park-and-ride programs; (i) supervision of wages, salaries, and non-transportation expenditures of C.T.C. in any subsidy arrangement; and (j) public relations and image building of transit as a mode of travel.

The author recommends, among other things, the purchase by public agencies and lease to Conestoga Transportation Company of 32 new 31-33 passenger, air-conditioned, radio-equipped buses for use in fixed-route, scheduled service; in order to ensure and maximize the improved public image of transit, the 32 buses should be purchased and delivered within a maximum time span of 2 years.

Future transit in Lancaster County may involve numerous modes, some of which are yet to be developed. The future transportation network may very well encompass private automobiles, monorails, buses, taxicabs, and aircraft, with varying degrees of public and private ownership and operation. If all modes of public transportation are to best serve the citizenry, there must exist an agency to provide intermodal regulation and coordination. Early city/county establishment of an umbrella-type transportation agency is, therefore, suggested; the agency would promote a comprehensive transportation system throughout Lancaster County and would assure regional planning for multi-modal, private and public integrated transportation. At the time of this report, there exists no local agency in Lancaster which has the means for, nor the authority to, perform ongoing studies, coordination, or regulation, direct or indirect, of transportation throughout the county.

NTIS Order #: PB-197-955
PC \$3.00, MF 95¢

Title: "A Study of Transit: Rock Hill, South Carolina"

Author: Public Research and Management, Inc.

Date: January, 1972

Project No. SC-T9-1

Keywords: 1. Small Cities
2. Bus, intracity
3. Bus, stations and shelters
4. Public Ownership
5. Poverty
6. Information Aids
7. Ridership, profiles
8. Surveys

Abstract: The report outlines results of a comprehensive technical study of transit in the Rock Hill, S.C., metropolitan area. Introductory material briefly traces the historical development of Rock Hill and its public transportation system. The present situation reflects a characteristic profile of declining patronage and rising costs which cannot be met through farebox revenues.

Planning characteristics of the study area are described with reference to land use, economics, population and demography, the Model Neighborhood Area, and other related factors.

The authors conclude that Rock Hill is exemplary of most typical urban areas with populations between 25,000 and 50,000; in this regard, the study revealed low-density development patterns, a decline of the central business district, and an almost total dependance on the private transportation mode.

The existing transit system is examined with reference to management, operating characteristics, and financial assets. Several area surveys were undertaken to determine the effectiveness of current transit operations and to synthesize recommended changes. These included surveys of transit riders, area employees, and a sample profile of area households. The report concludes that most transit riders are "captives" who otherwise lack access to private automobiles. In addition, present ridership is of a predominantly lower income category; bus lines serving low-income neighborhoods enjoyed sufficient patronage to warrant continuation. Many survey respondents were poorly informed of bus routes, fares, and schedules, and thus unable to effectively utilize transit service. Finally, the study revealed a marginal transit demand among the industrial employee population; most resided in low-density neighborhoods where automobile ownership is high.

Based upon these data, the authors advance several immediate recommendations for improving transit service in Rock Hill. A primary concern is the public acquisition and ownership of the transit system. The authors maintain, however, that bus service should be operated privately under a leasing arrangement with the City. The report also recommends creation of a transit advisory board to administer the controls necessary to insure continuance of a profitable transit operation. Three service improvement recommendations include: (1) institution of a complete bus scheduling and routing information system; (2) construction of bus shelters at major transfer and trip generation points; and (3) establishment of monitoring and surveillance systems to permit demand-responsive service.

NTIS Order #: PB-207-280
PC \$3.00, MF 95¢

Index No. 2-SC-1.1

Title: "An Action Program for Transit Improvement"
Author: Alan M. Voorhees & Associates (for Nashville Metropolitan Transit Authority)
Date: July, 1970 Proj. #: TENN-T9-2

Keywords:	1. Bus, intracity	6. Modal Split
	2. Bus, commuter	7. Ridership, profiles
	3. Bus, cost	8. Public Ownership
	4. Bus, stations and shelters	9. Government, urban
	5. Bus, transfers	10. Trip Generation
		11. Routes and Routing

Abstract: The report is a comprehensive overview of bus transit operations in Nashville, Tennessee, from which specific recommendations for a long-range improvement program were synthesized. In their introductory text, the authors note that operations by the Nashville Metropolitan Transit Authority reflect a common profile of declining ridership and rising costs.

The report begins with a general description of the transit system with reference to service characteristics, capital inventory, financial balance sheet, and passenger and mileage trends. The authors outline all relevant operational aspects such as routes and schedules, fare structure, maintenance program, scope of service, headways, safety record, and ridership. The authors note an 82.5% decline in patronage during the previous quarter century.

Alternative transit management systems are examined and compared between private and public variations. The Nashville Plan, adopted in 1958, created a regional Transit Authority empowered to acquire and operate the existing private system and to regulate mass transportation throughout the metropolitan area. Taxing powers of the Authority and its enabling legislation are discussed in detail. The report cites several advantages of public ownership, including tax exemptions and authority to operate unprofitable routes deemed to be in the community interest.

The results of surveys to determine various transit usage characteristics are examined in detail. The analysis covers such aspects as spatial travel patterns, modal split, trip generation, and a ridership profile. The authors conclude that general travel patterns gravitate towards the central business district, but that substantial patronage reveals non-central trip generation. This creates a sizeable transfer demand among 35% of all passengers. The data also indicate that the majority of riders are "captives" who otherwise lack access to a private automobile or other transportation mode. Based upon these data, the authors conclude that bus transit must have a continuing role in the present and near-future to provide mobility for a substantial population which does not enjoy access to alternative modes.

The report concludes with several specific recommendations for improving bus transit in Nashville. These include: (1) purchase of new rolling stock, (2) installation of bus shelters, (3) revision of the fare structure, (4) improved promotion and information programs, (5) charter sales, (6) acquisition of new maintenance equipment, (7) modification of routes to improve demand-responsiveness, and (8) installation of 2-way radios in buses. A total cost of \$4.2 million is estimated, broken down by year through 1980.

NTIS Order #: PB-204-886
PC \$3.00, MF 95¢

Title: "A Long Range View of Transit in Nashville"

Author: Alan M. Voorhees & Associates (for Nashville Metropolitan Transit Authority)

Date: September, 1971

Proj. #: TENN-T9-2

Keywords: 1. Urban Development, planning 7. People Mover
2. Bus, busway 8. Personal Rapid Transit
3. Bus, express 9. Guideways
4. Bus, intracity 10. Rights-of-Way
5. Bus, design 11. Corridors
6. Rail, systems planning and design 12. Trip Generation

Abstract: The report examines alternative transit systems and evaluates their potential for application in a long-range transportation improvement program for Nashville, Tennessee. The analysis focuses on systems which employ exclusive guideways and advanced technology to provide express service within an urban area.

The authors begin with an analysis of potential transit system implications from which basic selection criteria are developed. Four categories of such implications are examined, including: (1) resource allocation [ie. costs]; (2) urban environment [ie. pollution control and diversion of automobile traffic to reduce the need for highway construction]; (3) urban mobility [ie. increased mobility for "captives" of the transit system who lack access to an automobile]; and (4) urban structure [ie. improved control over regional development patterns and increased design flexibility for general urban planning].

In a general review of transit technology, the authors note several alternative classification schemes for transit systems. Individual analyses of potential concepts are outlined in detail for conventional, large-vehicle, and small-vehicle systems. Conventional designs include buses (ie. standard, articulated, double-deck, or minibuses on exclusive rights-of-way or in mixed traffic); rapid rail; and full-scale commuter railroad. Innovative large-vehicle technologies include buses on metered freeways, bi-modal buses, Dial-A-Bus, the Westinghouse Transit Expressway, monorail, the Gravity-Vacuum Tube, or Aerotrain. Small-vehicle designs include variations of the personal rapid transit concept which employ two-to-four passenger gondolas moving on an automated guideway. Each system is described in detail; the authors note, however, that in many cases state-of-the-art is insufficiently developed for implementation or that cost factors are prohibitive.

The report recommends development of express transit to meet demands projected for 1990. The discussion focuses on applicability of express busways and rapid transit systems. The report delineates several major transit corridors in the Nashville area capable of generating sufficient demand to warrant construction of the express rights-of-way. These were identified on the basis of highway congestion, location of trip generators, topography, and demography. The report also estimates probable patronage levels for the express service.

An evaluation of alternative transit systems is provided with reference to economic feasibility, capital costs, operating expenses, satisfaction of design criteria, land use impact and probable ridership at different station sites. The authors conclude that rapid transit and large vehicle systems are not feasible for implementation in Nashville. Improved surface bus service is recommended in conjunction with long range land use planning. The authors also recommend continued research and development of new transit technology, area transit patterns, and potential demand.

NTIS Order #: PB-204-948
PC \$3.00, MF 95¢

Title: "Transportation Planning in the Central Business District"
Author: Alan M. Voorhees & Associates (for Nashville Metropolitan Transit Authority)
Date: September, 1970 Proj. #: TENN-T9-2

Keywords: 1. Urban Development, planning 7. Trip Generation
2. Urban Development, renewal 8. Freight Movement
3. Traffic, analysis 9. Trucks and Truck Lines
4. Highway, planning 10. Parking, facilities
5. Pedestrians 11. Parking, planning
6. Modal Split 12. Center City

Abstract: The report summarizes a comprehensive technical study of transportation in the Nashville, Tennessee, central business district. The purpose of the study was to analyze and revise the current urban traffic plan and to recommend a framework for the continued evaluation of transportation and land use proposals.

The report begins with a detailed survey of existing conditions in the center city. The study area is examined with reference to its street system, traffic patterns, parking facilities, parking demand, transportation user characteristics, and truck activity. The authors note that an extensive system of one-way streets manages traffic control with a minimum of congestion and that completion of the proposed freeway system will relieve downtown corridors of heavy through-traffic during peak hours. The analysis projects continued economic vitality in the central business district which will generate additional future demands on the transportation system. The city is served effectively by a public bus transit network.

Two major problems were identified with reference to parking and commercial goods movement. The authors note that although parking is sufficient to meet demands, existing facilities are often poorly located to serve major trip generators. Truck loading spaces are not sufficient to satisfy demand, and the report recommends expansion and enforcement of parking regulations to eliminate curbside loading operations. All relevant data concerning modal split, user characteristics, trip patterns, and pedestrian volume are documented and compared to similar data from other cities.

Future developments are discussed with reference to land activity, parking supply, relocation of the central bus transfer center, construction of a Metro Center, and completion of the Interstate Highway System. The authors note that major renewal programs in the central business district will ultimately increase downtown employment by as much as 47%. Three alternative policies for expanding center city parking facilities are also compared. One major feature of the renewal program will be development of a Metro Center; the report notes consequent modifications necessary in the street and traffic network.

Plans and tests are outlined with which the authors projected future transportation requirements. These are advanced with reference to trip generation, traffic distribution, pedestrian travel, and transit trips. Survey data were studied to yield a recommended transportation improvement plan. Suggested development projects are examined within the specific context of downtown Nashville for the street system, public transit services, parking, pedestrian movement, and truck activities. The authors also briefly recommend a continuing process of evaluation and planning.

NTIS Order #: PB-204-932
PC \$3.00, MF 95¢

Title: "Wichita Falls Transit Study"

Authors: Pinnell-Anderson-Wilshire and Associates

Date: January, 1971

Proj. #: TEX-T9-1

Keywords: 1. Bus, intracity 6. Routes and Routing
2. Surveys 7. Employment
3. Ridership 8. Budget and Budget Planning
4. Trip Generation 9. Government, taxation
5. Financing Mass Transportation, 10. Community Response
requirements

Abstract: This is a study designed to collect all pertinent data relative to bus service in Wichita Falls and to identify the possible alternatives available. Once the alternatives were identified, they were evaluated to provide a basis for decision-making with regard to the future operation, ownership and service of a bus system in Wichita Falls. The scope of the study included the following major elements:

- . Analysis of the existing Bus System Operation
- . Analysis of Potential Demand for Bus Service
- . Determination and Evaluation of Alternate Bus Systems
- . Development of an Action Plan

To analyze the existing system a study was made of the Wichita City Lines, Inc. (a subsidiary of National City Lines, Inc., of Denver, Colorado). The study was designed to collect data on the existing facilities and operations (i.e. routes and service), fares, revenues and expenses, authorization for service, public information program, routes and coverage, patronage trends, schedule adherence, speed and delays, and passenger origin-destination study. The findings relative to the existing transit operation are depicted, supported by charts and maps.

A special survey was conducted to identify the characteristics of the transit users and non-user population and to obtain a sample of citizen opinion relative to transit service.

Five areas were selected for the Household and Transit On-Board surveys. Findings and conclusions are presented for socio-economic status, transit service, rider and non-rider evaluation and ridership attitudes.

There was no strong bias indicated against the City assuming the responsibility for the bus operation. However, the surveys did indicate some opposition locally on the question of the use of City tax funds to operate a bus system. A large group was not in agreement with this question which indicates a possible need for developing citizen support on this issue through a good public information program.

An employment survey was conducted to determine centers of industrial-commercial employment and to evaluate the extent of domestic employment. These studies were of special use since almost half of the transit trips were classified as being work trips. The results of the employment study indicated two major employment centers in the City which were not being served by bus routes.

Basic considerations are evaluated in the face of continuing bus service in the City, and it was concluded that public investment and/or ownership would have to be assumed. Based on this, the report presents bus system alternatives, financial analysis, and operational alternatives and recommendations.

NTIS Order #: PB-201-125
PC \$3.00, MF 95¢

Title: "Waco Transit Study"

Author: Vergil G. Stover and J.D. Benson (Texas A&M University, Texas Transportation Institute)

Date: December, 1970

Project No. TEX-T9-3

Keywords: 1. Bus, intracity
2. Financing Mass Transportation, requirements
3. Ridership

Abstract: The report reviews a comprehensive technical study of public bus transit operations in Waco, Texas. Services are currently provided by a private carrier, the Waco Transit Corporation. The system no longer generates sufficient patronage or revenues to sustain a private operation; the financial problems are further compounded by a need for major capital investments in new vehicles and relocation of the maintenance facility. Meanwhile, the system is judged to be performing a vital public service, providing mobility for an estimated 14,000 "transit captives" who lack access to alternative means of transportation. The purpose of this report was to examine the Waco transit system in detail and to synthesize a recommended improvements program.

All aspects of the current operation are examined with reference to operations and services, patronage and revenue trends, present ridership characteristics, service needs, public attitudes about transit, projections of revenue and expenses, and necessary capital improvements. Particular attention is given to the need for replacement of deteriorated capital stock.

Various ownership-operation alternatives are considered, including: (1) continued private management, (2) private management with public financial support, (3) public ownership with private management under contract, and (4) complete public ownership and operation. Some form of public ownership is recommended as the basis for participation in Federal assistance programs. The pricetag for all recommended capital investments would exceed \$907,000. Under a private management contract system, however, the report estimates that a revenue surplus could be attained. Additional survey data are appended.

NTIS Order #: PB-204-066
PC \$3.00, MF 95¢

Title: "An Urban Mass Transit Study for the City of Brownsville, Texas"

Authors: W. M. Peterson Consulting Engineers

Date: August, 1971

Proj. #: TEX-T9-4

Keywords: 1. Routes and Routing 4. Demography
2. Bus, station and shelters 5. Public Relations
3. Surveys 6. Information Aids

Abstract: This study comprehensively analyzes the two firms providing mass transit in the city of Brownsville, Texas, and it provides specific recommendations to the City Commission for upgrading the immediate future operation of these systems. These systems, Brownsville Transportation Company and Victoria Transportation Company, are privately owned, and they are non-competing firms in the sense that each has been assigned specific areas to serve.

A bus rider characteristics survey was conducted at the downtown stops of the two transit firms on a twelve hour-per-day basis for seven consecutive days from Monday, September 21, thru Sunday, September 27, 1970. Bi-lingual two-man survey teams were utilized at each stop, and approximately 850 interviews were completed. A community acceptance survey was conducted by telephone and was directed at a stratified random sample of one hundred Brownsville residents; names were selected from all pages of the Brownsville telephone directory by individuals who were not familiar with the city to assure complete impartiality in the selection.

The authors were able to conclude from the bus rider survey that approximately one third of the population of Brownsville resides in three specific Census tracts. All of these areas are basically very low income areas and are predominantly residential. Over one-half of the total riders originate in, or reside in these areas, thereby suggesting the possibility of expanded bus service at selected times. The fact that nine out of ten people walk almost one half mile to and from the stops, and that 7 in 10 use the buses daily also suggests expansion of the service in these areas as well as other low-income, high-density areas. Eight out of ten users have annual family incomes of less than \$7,000; seven out of ten earn \$3,000 or less, indicating there is a large group of people with very low incomes that are dependent upon the bus as their sole means of transportation. Seven out of ten people surveyed felt that the bus service could be improved. One indicative factor was that a "lower fares" request was almost always included, even with requests for "new buses", "air conditioning" and other obviously expensive improvements. This would appear to indicate a failure on the part of the bus firms to provide an effective public relations program to the citizens of the city in a manner which is easily understood and acceptable to them.

It is recommended that bus routes that presently parallel and overlap each other be revised in order to provide a greater service area. All routes should be periodically reviewed on the basis of existing street directions and conditions, traffic conditions, major housing and socio-economic changes, and passenger loadings. This review should be jointly implemented by the City and the operators to achieve maximum effectiveness for all concerned. There is also an urgent need for a central mass transit terminal in the central business district of Brownsville. The researchers recommend that both firms develop, print, distribute, publish and post at all bus stops a schedule of their operation, and the transit systems should adhere closely to the posted schedule. Any increase in existing fares should be held in abeyance until an extensive public relations program has been completed and the public images of the systems have been greatly improved.

NTIS Order #: PB-204-055
PC \$3.00, MF 95¢

Index No. 2-TEX-4.1

Title: "Improving the San Angelo Transit System, A Recommended Program"

Authors: Economics Research Associates and Alan M. Voorhées and Associates, Inc.

Date: September, 1971

Proj. #: TEX-T9-9

Keywords: 1. Ridership
2. Surveys
3. Demography
4. Age
5. Fares, reduction
6. Public Relations
7. Advertising and Promotion

Abstract: The purpose of this study is to insure that the City of San Angelo, Texas, will obtain maximum utilization of the new transit facilities and equipment that were provided through the City's approved Mass Transportation Facilities Grant. A short-range public transit improvement program was developed to maximize the use of present facilities and explore the feasibility of creating new facilities and services. A long-range transit improvement program was also formulated.

The study was based on information obtained from the City of San Angelo, the San Angelo Urban Transportation Study office, the American Transit Association and the Community Action Council of Tom Green County. The information gathered concerned revenues and expenditures of the San Angelo Transit System, system ridership history and characteristics, transit equipment and facilities, route locations and schedules, and other data regarding system operations. Information from the 1960 Census provided the data base pertaining to income, automobile ownership, employment, educational attainment, occupational skills, and age. Major residential concentrations were identified and plotted along with major traffic generators, including such transit generators as employment centers, commercial centers and concentrations, colleges and universities.

To determine transit usage, ridership data generated internally by the Bus Department of the City of San Angelo for the past several years were studied. On May 20, 1971, a ridership count and survey was made to obtain current and detailed bus patronage and ridership characteristics. Monitors were located on each of the City's nine in-bound bus routes to administer the survey questionnaire. Passenger counts were taken by route and by time-of-day, and questionnaires were distributed to patrons.

Several recommendations were generated by this study. The present fare structure should be revised as an incentive to increase patronage. Fares should be reduced to the following levels: (1) adults-25¢ per fare; (2) children and students under 12 years-10¢ per fare; and (3) children and students 12 to 18 years-15¢ per fare. Efforts should be immediately initiated to encourage increased charter bus service. On weekdays at least four first-class buses remain idle during off-peak hours. During weekends 8 to 9 vehicles remain idle. The productive use of this equipment could provide a significant supplement to passenger fare revenues.

It is further recommended that the City should develop and disseminate a variety of information on the changes to be initiated in the bus system operations. The general citizenry of San Angelo should be made aware of these reductions in bus fares. The most effective means of reaching a greater number of people will involve the use of the mass media. Advertising in the San Angelo Standard Times should be used, as well as spots on local radio and television stations.

NTIS Order #: PB-204-067
PC \$3.00, MF 95¢

Title: "A Transit Improvement Program for the Utah Transit Authority"

Author: Alan M. Voorhees and Associates, Inc.

Date: March, 1971

Project No. UTAH-T9-2

Keywords: 1. Bus, cost
2. Bus, commuter
3. Financing Mass Transportation, requirements
4. Routes and Routing
5. Public Ownership
6. Schedules and Scheduling

Abstract: The purpose of this report is to describe the following operating characteristics of the Utah Transit Authority: service provided, operations, revenues, costs, facilities, and equipment. It also presents a ten-year program for service and capital improvements to promote the system and upgrade facilities and equipment.

The Utah Transit Authority operates almost all of the local transit service in Salt Lake City and Salt Lake County. The Authority, created in 1970, acquired the operations of Salt Lake City Lines, Inc. (SLCL), a private carrier. Previously, the SLCL had been a wholly-owned subsidiary of National City Lines, Inc., a nationwide operator of transit facilities. Lake Shore Motor Coach Lines has an exclusive franchise for local transit service between Salt Lake City and Ogden, serving intermediate points in Davis County. Thirty-six weekday trips to or from Salt Lake City are scheduled, with stops made at seven downtown points. Limited Sunday service is also provided. Lewis Bros. Stages provides 18 scheduled weekday trips to and from its downtown Salt Lake City terminal and the Salt Lake County points of Granger, Hunter, and Magna, using sedan-type vehicles. There are also six trips scheduled to or from Tooele and the Tooele Army Depot.

All the routes operated by the Authority serve the central business district. A total of 134.5 route miles of service are provided; about 2/3 of this mileage is within the limits of Salt Lake City. Since some of the route miles are provided over the same streets, service is duplicated and the actual street miles of service are considerably less than the total operated. The measure of efficiency of a transit operation is the ratio between revenue passengers and bus miles driven. Most cities the size of Salt Lake City have experienced a decline in ridership recently, and their total patronage has dropped 21% between 1962 and 1970. The patronage drop has been much more drastic for City Lines, however; between 1962 and 1970, City Lines' annual patronage declined from approximately 10 million to 3.8 million rides, a reduction of 62%.

The authors have proposed a regional route system to be developed over a relatively short time span. This system of express commuter routes from outlying points uses freeways to be phased into operation over a 10-year period. The route system expands the present service area and provides more opportunity for east-west travel across the region. In later years, if the attraction of new riders permits, the authors propose to reinstate Sunday service, and to increase night and mid-day service frequency. A vigorous public relations effort is urged. To provide a more effective transit information system, it is suggested that the printed bus schedules be redesigned, with more informative route sketches, and with travel times indicated. A ten-year program of capital improvements has also been developed. It proposes to reduce the average age of the vehicle fleet to 7.5 years within three years time.

NTIS Order #: PB-204-076
PC \$3.00, MF 95¢

Title: "Reston Transportation Study"

Author: Alan M. Voorhees and Associates, Inc.

Date: June, 1970

Project No. VA-T9-2

Keywords: 1. Bus, intracity
2. Bus, express
3. Bus, commuter
4. Ridership, volume
5. Trip Generation
6. New Towns
7. Surveys
8. Corridors
9. Modal Split
10. Private Transportation, automobile
11. Traffic, analysis

Abstract: This study was instituted to evaluate the requirements of new towns for transit and to develop a system to serve the internal transportation needs of Reston, Virginia. The focus of this study is Reston in the 1980's. At full development the anticipated population will be 70,000-80,000 people living in about 19,500 dwellings. For transportation, the community will be served by two freeways and possibly by an express transit system in the median of the Dulles Airport access road.

Travel demands were determined by first estimating the number of trips at their source and their destinations broken down by trip purpose. A distribution model was developed to estimate the relative attractiveness of each trip generator to all other points. This model provided an estimate of the number of trips people make on a typical day and established the basis for subsequent phases of the study. These were: (1) a modal choice analysis of trip-making to estimate the number of people who will travel as transit passengers, and (2) an analysis of actual routes for trips by each mode using an assignment model. These models are mathematical relationships which due to the large number of calculations implicit in their processing required the use of high speed computers.

An Ad-Hoc Technical Advisory and Policy Committee with members from Reston, Fairfax County, the Virginia Department of Highways, the Metropolitan Washington Council of Governments, and the Federal Urban Mass Transportation Administration met on a regular basis to review study progress. The report stresses that meetings of the committee were an important part of the study from the aspect of pinpointing issues to which the planning process responded.

The findings of this study were based on field data and two home interview surveys which revealed the socio-economic and trip making characteristics of area residents. The report notes that residents favor a transit system and that children are likely to be the principal users. Walk trips were analyzed, but observations indicated that these trips were made mainly for social-recreation purposes and thus would not significantly diminish the number of vehicle trips made in Reston each day. Revenue for school buses and daily trips (both into and out of Reston) are estimated. Two transit and three highway networks were also tested to further analyze future needs. The results of this testing established the framework for the "Application of Test Results" presented in the report describing the recommended transit and highway systems as well as a first stage transit demonstration project.

NTIS Order #: PB-197-836
PC \$3.00, MF 95¢

Title: "A Transit Development Program for Spokane"

Author: Alan M. Voorhees and Associates, Inc.

Date: May, 1970

Project No. WASH-T9-2

Keywords: 1. Bus, stations and shelters 6. Industrial and Labor Relations
2. Fares 7. Maintenance, facilities
3. Ridership 8. Management, operations and techniques
4. Headways 9. Information Aids
5. Routes and Routing 10. Air Pollution

Abstract: In its effort to preserve and improve transit service in Spokane and its surrounding area, this report recommends guidelines for the Spokane Transit Commission. The report submits short and long-range plans. The short-range program recommends that criteria be established and guidelines be adopted for new routes and changes in or extensions of existing routes. Recommended actions are presented with respect to routes and headways, fares, factors affecting the passenger environment, special types of transit service, transit vehicles and garage facilities, labor relations, and management and administration. A proposed transit information program, which includes effective use of route and system diagrams, schedules, transit guide maps, bus stop markers, and transit advertising is also provided.

Organization and management goals are considered and specific actions to be taken by the transitional organization are included. The author stresses the importance of negotiations for the purchase of the capital assets of various transit operations, including the National City Lines in Spokane and other properties. Other topics include contracts for management and operation, continued provision of service into certain county areas and possible expansion of such service, and the formation of the Local Improvement Districts to make decisions in cases where county transit service is requested.

The Long-Range Planning Forecasts for 1980 indicate, if the quantity and quality of service remains constant, a level of patronage somewhat lower than at present; however, an aggressive improvement program for transit should improve the estimated level of transit ridership. The author finds that no case can be made for the provision of rail or other similar types of non-flexible rapid transit in Spokane until at least beyond the year 2000; this conclusion is based on an analysis of existing and forecasted population, employment and travel data gathered during the Spokane Metropolitan Area Transportation Study.

The report also discusses air pollution and contamination caused by the bus fleet; it is concluded that the use of diesel engine buses (as used by Spokane's Transit System) contribute less contamination to air than gasoline engines. It is recommended that the City retain its high standards by continuing to use the number one fuel for operating its buses. A capital improvements program for five years is proposed. A year-by-year outline of recommended improvements (including costs) is presented. The purchase of the land, shops, and equipment of the present National City Lines operation is the major item in the program. Appended material contains an abbreviated version of the statute related to formation and powers of the Metropolitan Municipal Corporation and its governing bodies.

NTIS Order #: PB-204-068
PC \$3.00, MF 95¢

Title: "Milwaukee Area Transit Plan" (Oversized Document)

Author: Barton-Aschman Associates, Inc.

Date: June, 1971

Project No. WISC-T9-1

Keywords: 1. Bus, rapid transit
2. Public Ownership
3. Highway, types
4. Propulsion Systems, turbines
5. Traffic, peak-hour
6. Traffic, congestion
7. Bus, busways

Abstract: Like virtually all mass transit systems in the United States today, the Milwaukee bus system is facing a critical situation; although the Milwaukee & Suburban Transport Corp., which owns and operates the system, has been rendering better-than-average service, it is caught between two conflicting pressures: (1) the continuing and severe decline in patronage, and (2) the constantly rising costs of labor and equipment. The author states that the point has been reached where the owners of the company could derive a greater return on their equity investment by placing it in conservative securities and avoiding all the strains and problems inherent in the operation of an urban transit system. However, a thriving metropolitan community such as Milwaukee cannot permit the further deterioration and possible ultimate discontinuance of its mass transit system.

After evaluating the various types of new transit equipment that are available or are in the process of development, it was concluded that a bus rapid transit system is most appropriate for Milwaukee during the years ahead. The author feels that a bus rapid transit system is capable of serving all segments of the population, while exerting the least harmful effect upon the environment. The recommended system, employing a new type of turbine-powered bus, will offer fast service which can be competitive with the private automobile. The comfortable new vehicles, with a speed capability of 70 mph., will travel on freeways with other traffic until they reach the point where travel speeds on the freeways normally drop due to rush-hour congestion; the transit vehicles will then move onto their own freeway -- a grade-separated bus roadway -- for the remainder of the trip.

The design criteria for the exclusive bus roadways make the facilities adaptable to any of the types of transit equipment that exist, or on which research has proceeded far enough to indicate feasibility. Consequently, roadways, ramps, and other special facilities built for the rapid transit bus can be utilized for new hardware if superior equipment becomes available in the future. The system offers the distinct advantage of being available soon at a relatively low development cost. Expenditures for special exclusive bus "transitways" would be made only in freeway corridors that are presently congested or are likely to become so in the near future. The expanded local bus system would provide 1,450 round trip route miles of service; of this, 887 miles would act as feeders to the rapid transit stations.

Under the conditions existing in the Milwaukee area at the time of this report, a sufficiently vigorous mass transit operation cannot be maintained by private enterprise. Therefore, the author recommends that Milwaukee County proceed with the acquisition of the operating facilities of the Milwaukee and Suburban Transport Corporation.

NTIS Order #: PB-205-006
PC Not Available, MF 95¢

Title: "East-West Transitway Location Milwaukee County Transit Study"

Author: Barton-Aschman Associates, Inc.

Date: October, 1970

Proj. #: WISC-T9-1

Keywords: 1. Routes and Routing
2. Right-of-Way
3. Distribution Systems
4. Land Use
5. Construction Costs
6. Center City
7. Computer, Programming
8. Computer, Applications

Abstract: The purpose of this report is to define the location of and prepare the preliminary design for an east-west rapid transitway in the East-West Freeway of Milwaukee corridor, from the Milwaukee county line to the central business district of the City of Milwaukee. It presents all the alignment data developed to date, summarizes the evaluation of alternatives, and recommends a narrow corridor for the alignment of the transitway.

Eight alternative route locations in the east-west corridor were considered and evaluated. Each of these alignments terminates at either the west or south fringe of the Milwaukee central business district. For all alignments, the westerly terminus of the transitway is immediately south of the East-West Freeway and in the general vicinity of 121st Street. All alignments interchange with the Zoo Freeway.

The Rank Sensitivity type analysis was used for all evaluations. The Rank Sensitivity analysis requires that objectives be stated in reasonably concise form, and that a unit of measure be developed so that one can gauge the extent to which each alternative achieves each object. The units of measure must be such that they can be quantified and converted to an index number. The indices are then used in a computer routine whereby repeated tests are made on the possible combinations of weighted or unweighted indices in their order of importance to determine which alternative plan is best. The evaluation procedure used for this location analysis was a two level technique. Five criteria were considered in the first level evaluation: (1) service to special generators, (2) joint project potentials, (3) service to the CBD, (4) land-use disruptions, and (5) transitway engineering and costs.

Based on the results of the first level evaluation, seven transitway alignments were chosen for the second level evaluation. Each of these lines was subjected to detailed design and cost analyses. These cost estimates included right-of-way, construction, utility, and contingency cost.

The authors recommend line 3B as the preferred transitway alignment. Line 3B consistently outranked line 3A in its ability to meet the objectives required of the east-west transitway. This alignment is strongest in factors or objectives which relate to service and development "potentials" while minimizing the disruption impact on existing development.

NTIS Order #: PB-210-277
PC \$3.00, MF 95¢

Title: "Bus Feeder Study for the Lindenwold Rapid Transit and the Camden, New Jersey Metropolitan Region"

Author: Praeger-Kavanagh-Waterbury, Engineers

Date: September, 1968

Proj. #: INT-T9-2

Keywords: 1. Bus, feeder
2. Land Use
3. Fares, cost determination

Abstract: The prime objective of this study is to establish the requirements for bus feeder service to the Philadelphia-Lindenwold Rapid Transit Line which will best serve the needs of the New Jersey populace while maximizing patronage of the rail line.

Anticipation of the opening of the Philadelphia-Lindenwold Rapid Transit Line has stimulated construction along its route, particularly in the Stratford-Lindenwold vicinity. Plans for development of land for malls, dwellings and service industries have been announced for the Ferry Station area and the Ashland Station-Lindenwold Station vicinity. Land use studies show a trend of industry moving from center city to a string of industrial parks which generally follow the line of the New Jersey Turnpike and Interstate Highway 295. Existing bus service has long been established in the North Camden County area. Practically all of it is oriented radially from Philadelphia and Camden center city. Although a bus can average 15 miles per hour or more on radial routes in the midday period, substantially slower speeds are recorded during the morning and evening peaks when the majority of riders use the buses.

Public Service Coordinated Transport is the principal carrier in the region with more than 40 routes. Red Arrow Lines operates about 20 buses on its single Route #54. Philboro Coach Corporation, Penn-Jersey Coachways, Inc., Cherry Hill Transit and Continental Trailways conduct operations which are principally interstate. Other operators are almost exclusively in the charter business.

The authors recommend that the Delaware River Port Authority initiate action to obtain legislation authorizing it to act as the regional transportation agency for the Camden-South Jersey region. In particular, the existing Compact Legislation of 1951 should be amended to make it clear that buses are an authorized means within DRPA jurisdiction and to remove the 35-mile limitation to give DRPA full transportation jurisdiction for any mode of common carrier in the "Port District" as defined in the present law. Such legislation should also treat special cases outside the "Port District" such as routes to Trenton. The DRPA should also acquire certain facilities of Public Service Coordinated Transport and Red Arrow Lines and operate the rail-bus transit system as the regional transportation agency of the Camden-South Jersey region. It is further recommended that, to accomplish this, DRPA apply to the U. S. Department of Housing and Urban Development for a capital grant for purchase of plant and equipment as described in this study.

Five fare zones with a base fare of 20 cents and an incremental increase per zone should be adopted for feeder buses. Buses not affected by the Philadelphia-Lindenwold Rapid Transit should retain fares as presently established. A discount fare between the rapid transit lines and the bus lines is not recommended, but present inter-bus discounts of 10 cents on a transfer should continue to be honored and should also be applied to cross-county trips.

NTIS Order #: PB-191-183
PC \$3.00, MF 95¢

Title: "Bus Feeder Study for the Lindenwold Rapid Transit and the Camden, N.J., Metropolitan Region -- Appendix to Report"

Authors: Praeger-Kavanagh-Waterbury, Engineers

Date: Undated Proj. #: INT-T9-2

Keywords:	1. Bus, feeder	6. Land Use
	2. Bus, cost	7. Trip Generation
	3. Intermodal Competition	8. Demography
	4. Employment	9. Government, state
	5. Qualitative Analysis	

Abstract: The report contains detailed appended material to a study of bus feeders for the Lindenwold Rapid Transit serving Camden, N. J. Eight separate appendices cover various aspects of existing mass transportation operations, area demography, and land use.

The first section is a history of transit in Camden and southern New Jersey between the opening of railroad services in 1834 and the present day. Introduction of trolley lines and steam railways during the early 1900's is discussed along with the development of automobile transportation. The authors note a constant erosion of demand for public transit service following World War I, largely in response to improved highway and bridge facilities connecting New Jersey areas with downtown Philadelphia. The report concludes, however, that substantial residual demand for rail transit exists.

The second section is a comprehensive analysis of economic data for Camden County. The analysis is concerned primarily with employment and income statistics broken down by place of residence, type of occupation, location of employment centers, production, and salaries.

The third section details land use field notes obtained in a comprehensive survey of the study area. Twelve sections were surveyed individually; data are provided with reference to an evaluation of area features, such as the quality of residential dwellings. The result is a detailed overview of land use throughout the metropolitan area which includes approximate qualitative distinctions among various communities and an inventory of such physical features as roads, schools, and commercial establishments.

The fourth section notes principal "attraction centers" such as factories, schools, business districts, and similar trip generators of interest to transportation planners. An estimate of the population at each specific center is included.

The fifth section is a complete inventory of facilities, rolling stock, and other capital equipment available to the proposed feeder line. A sixth section reproduces relevant state ordinances outlining specifications and other regulations for bus vehicles. The seventh section provides complete personnel data for the Public Service Coordinated Transport company which will operate the feeder service.

The final section lists recommended routes for feeder buses along with projected annual revenues for each line. Eight routes covering more than 4,000 miles will be operated at a daily cost of \$3,330 and requiring a capital investment of more than \$1.7 million.

NTIS Order #: PB-191-184
PC \$3.00, MF 95¢

Title: "St. Louis Metropolitan Area - Rapid Transit Feasibility Study Long-Range Program"

Authors: Parsons Brinckerhoff-Tudor-Bechtel-Sverdrup & Parcel

Date: August, 1971

Proj. #: INT-T9-4

Keywords:	1. Surveys	4. Ridership
	2. Routes and Routing	5. Right-of-Way
	3. Financing Mass Transportation, requirements	6. Trip Generation

Abstract: The purposes of this study were to determine the type of mass transit system or systems most appropriate for St. Louis in the future; to evaluate alternative system configurations and routings; and to provide the community's decision-makers with sufficient information concerning costs, benefits and related factors to permit selection and early implementation of a plan to guide the development of the area's transit system.

The study consisted of three broad phases. Phase I was concerned with data gathering, but also included analysis of existing transit service and transit trip-making characteristics, which formed the basis for the subsequent study phases. Data were obtained from a sample home interview travel survey, school trip surveys, an inventory of facilities, supplementary transit surveys and counts, and a review of historical trends and previous studies. Phase II was concerned with the anticipated future growth of the area and changes in its socio-economic characteristics that are likely to affect transit requirements, development of public transportation system policies, and an evaluation of conventional and alternative future transit systems. In accordance with the decision reached by the Bi-State Development Agency and the East-West Gateway Coordinating Council, the two alternative systems selected for Phase III analysis were: (1) a system of buses using the existing and proposed future highway network with improvements that could be achieved at modest cost, and (2) a train (rail mode) system running on a grade-separated, exclusive right-of-way. The early portion of Phase III consisted of an analysis and presentation of the advantages and disadvantages for the St. Louis area of each of the systems. The decision was then made to proceed with an order-of-magnitude planning approach for an area-wide train system supplemented by a complementary surface bus system.

As a result of the investigations and analyses carried out during the course of the study the following conclusions were reached: (1) Revenues from the new transportation system will be adequate to cover operating costs, including contingency and depreciation on vehicles. (2) If rapid transit is to be implemented in the St. Louis area, it should utilize steel-wheel/steel rail, air conditioned vehicles operating in automatically controlled trains with minimum headways of 90 seconds. (3) The forecast growth of the study area from a population of about 2,300,000 in 1965 to almost 3,200,000 by 1990, accompanied by a corresponding growth in employment opportunities and changes in the socio-economic characteristics of the inhabitants, will result in 60-percent more trips being made on a typical weekday in 1990 than were recorded on a typical weekday in 1965.

The authors recommend that a continuing public transportation planning effort be established which would coordinate transit development with the planning of highways, urban renewal and development projects, and other related activities. This planning effort should also include the monitoring of public transportation research, development, and demonstration projects potentially applicable to the needs of the St. Louis Metropolitan Area.

NTIS Order #: PB-204-060
PC \$3.00, MF 95¢

Title: "St. Louis Metropolitan Area Rapid Transit Feasibility Study Long-Range Program, Supplemental Report"

Author: Parsons Brinckerhoff-Tudor-Bechtel-Sverdrup & Parcel

Date: August, 1971

Project No. INT-T9-4

Keywords:	1. Rail, systems planning and design	6. Construction, cost
	2. Vehicle, design	7. Right-of-way
	3. Routes and Routing	8. Ridership
	4. Bus, feeder	9. Tunnels and Tunneling
	5. Rail, stations and terminals	10. Quality Control

Abstract: The purpose of this supplemental report is to present the proposed criteria, vehicle design specifications, station configuration, construction methods, operating characteristics, route descriptions, and estimates of cost for a steel-wheel/steel-rail transit system for the St. Louis Metropolitan Area. The suggested long-range transit program envisions a system consisting of a grade-separated transit system on an exclusive right-of-way utilizing new construction for at-grade, aerial, and subway structures. In addition, a comprehensive bus system would be integrated into the system as an essential element to be used for feeder-distributor service in support of the rapid transit and Kirkwood Line stations and to accommodate travel demands not conveniently served by the transit routes.

The proposed rapid transit system consists of eight lines (five in Missouri, two in Illinois, and one connecting the two states). An additional line, the Kirkwood Line, is suggested as a possible addition to the long-range transit program, provided that the right-of-way and trackage can be provided at low cost. A complimentary bus system would provide feeder-distributor service for the rapid transit system and the Kirkwood Line, and transit service to areas not directly served by these lines. Detailed route descriptions are given for each line.

The general design criteria for the system were established not only on the basis of adherence to strict engineering standards, but also with the realization that rapid transit must be competitive with private automobiles. Two factors are involved: convenience and comfort. For the passenger, an important aspect of convenience is his not having to wait a long time for a train; thus, it was established that during operating hours, the maximum headways for trains would be only ten minutes. Comfort was accounted for in part by the provision of adequate seating, incorporation of noise control techniques, air conditioning of the cars, and heating and air conditioning of the stations.

Three basic types of construction were considered for the project: subway, aerial, and at-grade. With subway construction, community disruption and dislocation of people and businesses would be minimal. Stations can be mined out, which further reduces disruption at the surface. Because of these advantages, and because the estimated cost of tunneling in the rock formation is competitive with the cost of aerial structure plus rights-of-way, it is planned to construct more than 67 miles of the rapid transit system underground.

Patronage estimates were made for the year 1990 on the assumption that the rapid transit lines, the Kirkwood Line, and the complimentary bus network will be in full operation. The total patronage estimated for the long-range transit program was 600,000 daily trips.

NTIS Order #: PB-204-061
PC \$3.00, MF 95¢

Title: "KCI Rapid Transitway -- Engineering Design Report Forecast of Passengers, Revenue, and Operating Costs"

Authors: Howard, Needles, Tammen & Bergendoff

Date: December, 1969

Proj. #: INT-T9-5

Keywords: 1. Budgets and Budget Planning 3. Bus, cost
2. Airport, access 4. Fares, cost determination

Abstract: This report is a forecast of revenues and expenses for the Rapid Transitway from the Central Business District of Kansas City, Missouri, to the Kansas City International Airport. All estimates of revenues and expenses are expressed in 1969 dollars; although inflation may materially affect actual costs, the authors feel that fares will increase proportionately.

The number of potential users of the proposed KCI Rapid Transitway System is a direct function of the number of air passengers at KCI; all estimates and analyses of this study have been based on the expanded air passenger forecast data which were collected by the Federal Aviation Administration in recent surveys. Total air passengers at KCI were taken as two times the forecasted enplaned passengers; air passenger origins and destinations in the area were projected to be 89 percent of enplanements and deplanements, since experience indicates that about 11 percent are transfer passengers at Kansas City Municipal Airport.

For purposes of estimating the bus requirements, buses were scheduled on the basis of specified headways with each bus stopping at all three terminals. Minimum headways were set at 30 minutes between midnight and 7 a.m., and 15 minutes between 7 a.m. and midnight; typical headways in initial years for peak-hours are estimated to be 5 minutes. Prior to completing the transitway, the round-trip running time is estimated to be 2 hours, 10 minutes during the base and 2 hours, 30 minutes during the peak period; after completion of the transitway, the round-trip running time will be reduced to 1 hour, 30 minutes. An estimated 20 buses are required to begin service in 1971 (projections are made through 1990); the total number of buses required each year includes the number necessary to handle peak demand, plus an allowance of 10 to 15 percent normally needed as spare or standby buses.

It is estimated that total maintenance and replacement costs over a period of years will average \$200,000 per year; this amount will provide for annual maintenance and the accumulation of a maintenance reserve to meet periodic major expenditures. Annual estimates of the capital requirements for buses include costs for financing the initial 20 buses required to begin service in 1971, costs for additional buses required each year due to growth of passenger demand, and a reserve fund for replacement of buses at the end of 10 years of operation; the cost of buses was estimated at \$50,000 for new buses, and \$30,000 for replacement buses, because of the re-sale value of the buses replaced.

The fare charged for bus service will affect passenger usage. The estimated Transitway bus passengers have been determined on the assumption that the fare will not exceed \$2.00. As the fare is increased, there will be a corresponding decrease in patronage. It has been assumed for the purposes of this report that the City of Kansas City will charge a 10 percent franchise fee; therefore, the corresponding net fares (for revenue computations) are \$1.80 and \$2.25. Estimated passengers for a \$2.25 fare have been decreased 15 percent, and the Maintenance and Operations costs have been decreased, based on the reduction in required buses.

NTIS Order #: PB-191-145
PC \$3.00, MF 95¢

Title: "KCI Rapid Transitway - Engineering Design Report: Investigations, Preliminary Plans, and Project Costs" [Oversize Document]

Authors: Howard, Needles, Tammen and Bergendorff (for Kansas City Area Transportation Authority)

Date: October 20, 1969

Proj. #: INT-T9-5

Keywords:	1. Right-of-Way	6. Construction, costs
	2. Land Use	7. Construction, materials
	3. Access, planning and control	8. Bus, busway
	4. Interfaces	9. Bus, feeder
	5. Overpasses	10. Modal Split
		11. Guideway
		12. Highways, surfaces

Abstract: This is a preliminary engineering design report summarizing the results of studies of a Rapid Transitway from 12th Street in the central business district (CBD) of Kansas City, Missouri, to Kansas City International Airport. It is to serve as a basis for the development of final construction plans for this facility. The overall objective of this report is to develop engineering designs and estimates of costs of the proposed transitway.

Recommendations made by this report are that: (1) a terminal building be constructed in the CBD; (2) the transitway leaving this terminal be elevated on a structure throughout the downtown area; (3) a new bridge be constructed across the Missouri River for the transitway; (4) interfaces for other modes of transportation be created with the transitway; (5) rights-of-way be created alongside existing highways; (6) the transitway enter the airport on its own roadway, parallel to, and at the same elevation as the Inbound Entrance Road; and (7) any other structures necessary to the smooth operation of the transitway be constructed where necessary according to this report, such as retaining walls, overpasses, concrete pavement, guard rails, fences, and lighting.

Estimated costs for this project are: (1) roadway construction - \$6,909,000; (2) Bridges - \$16,049,000; (3) Engineering and contingencies \$3,500,000; and (4) Right-of-Way including acquisitions - \$2,992,000. Total cost for this project is estimated to be \$29,450,000.

Specially constructed express buses will operate on the transitway until such time as a monorail or another advanced system becomes operational. Should the monorail prove feasible, the transit buses will then become primarily a feeder for the monorail system and will also serve as an auxiliary or standby unit.

To support its recommendations, the report provides tables, illustrations, and an appendix which detail costs, equipment, perspectives, structural designs, and passenger forecasts.

NTIS Order #: PB-191-144
PC \$3.00, MF 95¢

Title: "Analysis of Public Transit Legislation"

Author: Kansas City Area Transportation Authority

Date: 1970

Proj. #: INT-T9-6

Keywords: 1. Government, Urban
2. Government, State
3. Financing Mass Transportation, sources
4. Government, Taxation
5. Government, Federal
6. Government, Intergovernmental Relations

Abstract: The report is a summary of national experience with public transit legislation. Its primary objective is to document the statutory provision of operational subsidies for urban mass transportation in other states which can be applied to the Kansas City metropolitan area. In a brief overview, the author notes that the latter system reflects a characteristic profile of declining ridership and rising costs which cannot be met through farebox revenues. The nature and role of Federal grants-in-aid is also discussed, but found to require such a large local commitment in matching-fund programs that supplemental sub-Federal assistance remains necessary.

The report contends that long range indications are towards the attraction of substantial new patronage and revenue, but that two expensive prerequisites must first be attained. These include: (1) modernization of transit equipment and facilities; and (2) improved management, both of which are largely contingent upon adequate state and local legislative assistance. The report documents results from a survey poll conducted among 14 major transit companies nationwide which revealed Kansas City to be the only one whose substantial operating losses were not covered by public subsidies. The author examines briefly the sources of public revenue made available to companies in the other states, and notes a wide diversity in statutory precedents.

The report does not recommend specific legislation for subsidizing mass transit in the Kansas City metropolitan area. The report does, however, provide a state-by-state analysis of relevant legislation, broken down by operations covered, taxing authority, direct assistance, and indirect assistance. The purpose of these data is to suggest precedents with which specific legislative provisions for subsidizing the Kansas City transit system can be fashioned.

A final section of the report documents specific citations from the various state laws which pertain to the financing of mass transit operations.

NTIS Order #: PB-201-910-U
PC \$3.00, MF Not Available

Title: "Transit Improvement Plan"

Author: Kansas City Area Transportation Authority

Date: February, 1971

Proj. #: INT-T9-6

Keywords: 1. Ridership, volume
2. Trip Generation
3. Urban Development, planning
4. Fare, cost determination
5. Bus, intracity
6. Bus, cost
7. Bus, school bus
8. Routes and Routing
9. Demography
10. Rail, systems planning and design
11. Financing Mass Transportation, requirements

Abstract: The report summarizes results of a comprehensive examination of mass transportation in the Kansas City metropolitan area to evaluate current operations and to synthesize recommendations for both long and short-run service improvements. A principal objective of the study was to collect usage and demand data from which future transportation requirements could be projected.

The report begins with a service area analysis which plotted the existing population distribution and regional employment pattern. Anticipated changes in these key variables through 1975 are discussed as the basis for evaluating long-range transit demand. Current transit usage is examined with reference to the overall market and results of a 1970 origin-destination survey. These data were used to identify major trip generators and to estimate the potential market for public transportation in 1975.

Existing operations are examined with reference to capital stock and the transit network. A complete inventory of transit real estate, facilities, and rolling stock is included along with a brief description of the general system. Results of a line analysis indicated wide diversity among different routes in terms of ridership and economy.

Short-term recommendations generated by the study include revision of the fare structure, acquisition of at least 300 new coaches and related hardware, and relocation of the physical plant in a wholly new facility. The authors also recommend integration of privately-owned and operated school bus services within the Area Transit Authority. In addition, the line analysis revealed a compelling need for subsidies amounting to nearly \$1.5 million per year in order to maintain the present service.

The report gives particular attention to a nine-point transit improvement program designed to rebuild the existing system over a three to five year period. Key elements of this proposal include: (1) adjusting the routing network to reflect existing and projected demand patterns; (2) providing both a primary and a secondary transit system to serve inter-area and local demands; (3) substitution of subscription express service for regularly scheduled linehaul commuter service; (4) readjustment of the fare structure; (5) provision of fare passes on major lines, and other proposals. The report also recommends construction of a major rail rapid transit system for airport access and high-speed commuter service as the principal element of a long-range development program. A final section of the report analyzes administrative procedures and financing alternatives. Textual material is supplemented by graphic illustrations, maps, and relevant statistics throughout.

NTIS Order #: PB-201-922
PC \$3.00, MF 95¢

Title: "PATH Station Modification and Rehabilitation Technical Study"

Author: Port Authority Trans-Hudson Corporation

Date: UNDATED

Project No. INT-T9-15

Keywords: 1. Rail, stations and terminals
2. Underground, structures
3. Quality Control

Abstract: The report summarizes a comprehensive technical study of the Port Authority Trans-Hudson (PATH) subway system. The latter was established in 1962, following acquisition of the bankrupt Hudson and Manhattan Railroad, to operate rapid transit services between Manhattan terminals and the cities of Newark, Jersey City, and Hoboken, N.J. The present study examined ten of the thirteen PATH stations and recommended specific improvements with regard to amenities, services, and environmental quality.

The report contains a general history of the PATH system, including objectives and goals which guided the station analysis. General recommendations are advanced with reference to: (1) construction materials, (2) lighting, (3) fare collection, (4) information aids, (5) station access, (6) passenger amenities, (7) accommodation of elderly and handicapped riders, and (8) safety. In addition, specific recommendations are advanced for the re-design or rehabilitation of each of the ten stations.

The report concludes with a brief discussion of the \$16.3 million implementation program and a description of the study and design processes.

NTIS Order #: PB-210-618
PC \$3.00, MF 95¢

Title: "Urban Mass Transit Planning Project -- Technical Report #2, Computer Program Specifications"

Author: Alan M. Voorhees and Associates, Inc.

Date: October, 1966 Proj. #: TRD-3

Keywords: 1. Computer, programming
2. Computer, application
3. Algorithms

Abstract: The purpose of this report is to describe the development of a series of computer programs for transit planning. The study presents the results of an intensive effort to convert the full range of needs in the field of transit planning into a set of detailed computer program specifications. In the course of this work, numerous compromises were required between what is desired and what is feasible in light of computer technology, time and budget available for programming, and the state of knowledge in the field of transit planning.

The second section of this report presents the overall transportation planning process, the relationship of transit planning to this process, and specifically describes the function of the transit planning computer programs in the implementation of this process. No attempt is made to describe the individual programs but rather, its purpose is to set the analytical planning framework within which they would operate. This description is divided into two sections: Calibration and Forecasting. These processes are presented in both verbal and flowchart form.

The third section presents detailed specifications of the individual programs. These specifications set forth the input, methodology, and output of each program. In addition, a flow chart of each program is presented. Header cards, options, and parameters will be read by main program with FORTRAN read. NAMELIST will be used to read options and parameters. Appropriate common variable names will be used. Only those parameters which cannot be deduced by the program will be required to be user-supplied. FORTRAN input will be used only for header, options, and parameters. It will not be used for data input. Physical input/output will not be used, but rather the input-output control system. FORTRAN output will be utilized only for diagnostics and message, special binary output, and debugging.

The appendices of the report describe several algorithms that can be used in finding paths through a transit system.

NTIS Order #: PB-180-485
PC \$6.00, MF 95¢

Title: "Urban Mass Transit Planning Project -- Technical Report #3, Volume I:
IBM 7090/94 Computer Programs General Information Manual"

"Urban Mass Transit Planning Project -- Technical Report #3, Volume II:
IBM 7090/94 Computer Programs Users' Reference Manual"

Author: Alan M. Voorhees & Associates, Inc.

Date: April, 1967 Proj. #: TRD-3

Keywords: 1. Computer, applications 4. Trip Generation
2. Computer, programming 5. Codes and Coding
3. Modal Split

Abstract: The reports describe a sophisticated computer application prepared for the Urban Mass Transportation Planning Project. The purpose of this project phase was to develop specific computer programs with which to evaluate demand-satisfaction by urban transit systems. The programs described in these reports provide reliable estimates of ridership volume throughout an entire urban network or on any segment thereof, based upon projections of modal split. In addition, the user can easily alter the system and test the effects resulting from changes in demand and service. The programs were prepared for the IBM 7090/94 computer.

Volume I describes program applications and other general information. Two basic data inputs to the system include calibration of the existing urban transportation network (including transit and highway systems, trip characteristics, and modal split) and forecasting of a hypothetical future transit configuration. These data can then be processed to forecast modal split and its consequent requirements for transit. The report contains a detailed flow chart of all programming operations. Additional sections include a network coding manual and illustrations of the mechanics and capabilities of the transit path-finding program. A final chapter outlines the utility of modal split programs. These are designed to reflect trip movements which result from trip distribution between alternate transportation modes. The authors conclude that such analytical instruments are particularly useful in long-range urban planning programs where new construction must accommodate probable demands for transport between high-volume zones.

Volume II consists of actual program write-ups. Program inputs, deck and control card set-ups, and sample reports and messages are all provided in detail. The report serves principally as a user's manual and contains specific outlines for eleven individual programs.

NTIS Order #: [Vol. 1] PB-180-486
" " " [Vol. 2] PB-180-487
Each Volume: PC \$6.00, MF 95¢

Index No. 3-00-3.2

Index No. 3-00-3.3

257

Title: "Urban Mass Transit Planning Project -- Technical Report #4: Modal Split Simulation Model"

Author: Alan M. Voorhees & Associates

Date: August, 1967 Proj. #: TRD-3

Keywords: 1. Modal Split
2. Trip Generation
3. Computer, applications

Abstract: In its broadest context, modal split deals with aggregates of trips made by individuals and, also, the way in which these trips are divided among the various modes of travel. In this generalized view, modal split is concerned with the distribution of all travel by all persons among all possible modes of travel.

The problem of modal split, at least conceptually, is separable into two components. First, there is the problem of understanding what motivates transit usage. After finding what it is that motivates the choice of one of many competing modes, there is still the second component of the modal split problem - prediction. Prediction has two aspects: (1) what the future transportation systems will be like, and (2) given the future transportation systems and an understanding of modal split, what the future modal split will be.

It is the purpose of this study to examine modal split; there are three stages to the examination. First, the major modal split models are examined to determine which variables, as the key determinates of modal split, should be included in any modal split model; this is the subject matter of Chapter II. Second, in Chapter III, a particular modal split model is selected for further evaluation in the context of varying urban settings. In Chapter IV, the third step, a simulation model, is presented.

The simulation model, when implemented, will accept the modal split model of Chapter III as input; based on the results of applying the modal split model to a variety of urban configurations, the simulation model, the author notes, will shed additional light on the problem of urban form affecting modal split.

NTIS Order #: PB-180-488
PC \$6.00, MF 95¢

Title: "Urban Mass Transit Planning Project, Technical Report #5: Recommendations for Urban Mass Transportation Research"

Author: Alan M. Voorhees and Associates, Inc.

Date: December, 1967

Proj. #: TRD-3

Keywords:	1. Government, Federal	5. Advertising and Promotion
	2. Industrial and Labor Relations	6. Land Use
	3. Bus, school bus	7. Management, planning and analysis
	4. Bus, priorities	8. Management, training techniques
		9. Research Operations

Abstract: The report specifies topics for recommended future research and development projects in the field of urban mass transportation. The introductory text examines sources of Federal financial assistance for R&D, and concludes that despite comprehensive programming, substantial knowledge gaps remain with reference to certain basic transportation issues.

The authors identify four broad categories of research disciplines relevant to the planning and operation of mass transportation. These include: (1) administration, (2) systems design, (3) urban travel characteristics, and (4) education and training. Twenty-three specific research topics are recommended within these guidelines, broken down by problem, proposed study, and research strategy.

Six administrative research topics are advanced, including: (1) legal impediments to improved transit service, (2) the effect of labor regulations on improved transit, (3) advantages of an Urban Transportation Management Advisory Center, (4) the relationship between school bus and transit service, (5) the effectiveness of transit marketing, and (6) the implications of rising labor costs.

Seven systems design proposals are advanced, including: (1) the impact of rapid transit on land use; (2) a study of forecasting techniques, planning procedures, and impact analysis of the Bay Area Rapid Transit system in San Francisco; (3) the development of improved analytical and management tools; (4) application of traffic engineering improvements to transit systems design; (5) the impact of transit systems on urban structure; (6) a comparative case analysis study; and (7) the effects of special vehicle priorities on urban freeway lanes.

Six topics with reference to urban travel characteristics are delineated, including: (1) the impact of transit service on travel patterns, (2) the effect of improved service on transit patronage, (3) land use transportation requirements, (4) data requirements for an origin-destination survey, (5) the comprehensive analysis of factors influencing mode choice, and (6) travel between airports and adjacent metropolitan areas.

Finally, four proposed education and training projects include: (1) specialized training programs, (2) specialized training materials, (3) creation of a transportation information center, and (4) development of an urban transportation management course.

The report does not attempt to recommend priorities among the proposed research topics; rather, it seeks to provide an inventory of relevant study projects from which such priorities can be developed.

NTIS Order #: PB-180-489
PC \$6.00, MF 95¢

Title: "Urban Mass Transit Planning Project -- Technical Report #6, Volume I:
IBM System/360 Computer Programs General Information Manual"

Author: Alan M. Voorhees & Associates, Inc.

Date: January, 1968

Project No. TRD-3

Keywords: 1. Computer, programming
2. Modal Split

Abstract: This report is one in a series describing the development and utility of a battery of computer programs for the planning of public transportation systems. Prior reports describe the technical considerations and specifications which formed the programs' design. The present report is one of two volumes which contain general information about the program applications, and it emphasizes general capabilities and data preparation.

Chapter II of the manual relates the programs to the overall transit planning process and describes the programs as a set of interrelated elements forming a software system. The chapter sets an analytical planning framework within which the programs operate and discusses data interface.

Chapter III describes the transit network program; it also serves as a network coding manual. Chapter IV summarizes the mechanics and capabilities of the transit path-finding program; it does not, however, set forth the algorithm which is used in building transit paths, as this may be found in Technical Report #2. Chapter V tells how to make effective use of the data reduction, regression, and modal split programs which are intended to cover a wide range of applications. The author notes that the programs can analyze large networks at a fine level of detail.

NTIS Order #: PB-180-490
PC \$6.00, MF 95¢

Title: "Urban Mass Transit Planning Project, Technical Report #6 -- Volume II:
IBM System/360 Computer Programs Users' Reference Manual"

Author: Alan M. Voorhees & Associates, Inc.

Date: January, 1968

Proj. #: TRD-3

Keywords: 1. Computers, programming

2. Modal Split

Abstract: This manual summarizes information pertaining to the operation of a package of IBM System/360 computer programs for use in long-range planning of public transportation. The manual is intended as a concise reference for those who are familiar with the usage of computer programs for transportation planning. A description of the analytical framework in which the programs function appears in Volume I of this report, "General Information Manual."

The programs in the package are written in FORTRAN IV(G) and 360 Assembler Language using the full Operating System/360. Although each program is an entity, all are interdependent in that one creates or reads the input or output of another. The Operating System is well suited for the sequential execution of any set of programs. To accomplish these tasks and to effect their linkages, information is needed on how to communicate with both the Operating System and the subject programs.

The second chapter of this manual contains information to assist in communicating with the Operating System through Job Control Language. The third chapter presents the "language" or means of talking to the subject programs. The remainder of the manual consists of summaries of operating instructions for each program.

The table of maximum parameters which appeared in Volume I is reproduced; the maximums represent typical values only and will vary depending on machine size, number of lines on each link, number of links connected to each mode, number of variables used in modal split, etc. The flow chart showing the Transit Planning System is also reproduced.

NTIS Order #: PB-180-491

PC \$6.00, MF 95¢

Title: "Urban Mass Transit Planning Project -- Technical Report #1: Factors Influencing Transit Planning"

Author: Alan M. Voorhees & Associates, Inc.

Date: October, 1966

Project No. TRD-3

Keywords: 1. Modal Split
2. Trip Generation
3. Ridership, profiles
4. Computer, applications
5. Computer, programming
6. Urban Development, planning

Abstract: The report develops parameters for a set of computer programs designed specifically for transit planning in urban areas. The authors attempt to delineate information outputs and data requirements which will best serve the needs of transit management and planning.

A comprehensive literature survey was undertaken to assess the progress in transit planning technology. The authors note that most recent efforts have concentrated on developing modal split models which allocate projected travel demands among different transportation modes. Various approaches to this subject are reviewed. The analysis revealed three general groups of independent variables, including: (1) origin variables [relating to demographic characteristics of transit users]; (2) interchange variables [relating to performance characteristics and relative "costs" associated with alternative transportation modes]; and (3) variables related to the origin and destination of a specific trip. The authors conclude that a computer program for transit planning must accept sets of these three variables.

Additional requirements for the computer system were revealed through conferences with professional planners and a questionnaire distributed by a committee of the Highway Research Board. Six major problem areas in transit planning appeared with reference to estimating usage, revenues, and costs for a given system; quantifying the effect of transit improvements on land use development; allocating broad social and economic costs and benefits to various transportation improvement proposals; and scheduling of transit vehicles within the constraints of work rules, equipment limitations, and public regulations. Each of these problems is described in detail.

The functional specifications for six computer programs are outlined in response to the problems raised above. The Network Building Program allows translation of a transit system into numerical form. The Path Finder Program traces the movement of a traveler among zones in an urban area. The Path Summary Program produces measures of interzonal impedance through the network. The Assignment Program employs outputs from the first two programs to yield link volumes for segments throughout the urban network. The Data Reducer Program performs reduction of information in matrix form into linear form. Finally, the Modal Split Program calculates zone-to-zone travel demands by mode from an estimate of total personal movements.

Appended material includes a bibliography from the literature survey, conference notes, and a sample of the questionnaire instrument.

NTIS Order #: PB-180-484
PC \$6.00, MF 95¢

Index No. 3-00-3.8

Title: "Modes of Transportation - Sources of Information on Urban Transportation, Report #2"

Author: Journal of Urban Transportation Corporation

Date: August, 1968

Proj. #: TRD-6

Keywords:	1. Bibliographies	5. People Movers
	2. Bus	6. Pedestrians
	3. Rail	7. Private Transportation
	4. Ridership	8. Quantitative Analysis

Abstract: This report is primarily an inventory of modes of urban transportation classified by vehicle types, with subclasses by guideway where applicable. Over 100 vehicle systems which have been demonstrated, or are currently operated, are described and referenced. In addition, 124 proposed systems are listed. A background on vehicle performance and an extensive appendix on rail transit systems are included.

In essence, this manual is a type of encyclopedia which lists, defines, describes, references and cross-references numerous modes of urban transportation. Included are technical reports on sources of information and state of knowledge reviews in transportation designed to give a general background on transportation to readers working in allied fields. The sections concerning the sources of information on urban transportation include: (a) Sources and Dissemination, (b) Modes of Transportation, (c) Passenger Psychological Dynamics, (d) Urban Transportation Planning, and (e) Comparative Economics of Urban Transit Operations. References to other sections in this report are shown in the body of the text, or in footnotes in brackets. Page numbers of cited sources generally follow the author's name or quotation in the text in parenthesis; page numbers may also be found immediately following the citation in footnotes or bibliography if not otherwise noted.

The major modes of urban transportation include: Walking; Powered Pedestrian Aids (Moving Stairs, Moving Sidewalks, and Elevators); Personal Service Vehicles (Bicycles, Motorcycles, Mopeds, Motor Scooters, etc.; Passenger Automobiles, Taxicabs and Limousines, Taxi Buses; GM-RCA "Autoline" Electronic Highway, and StaRRcar); Small Vehicles - Public Transit Systems (Aerial Tramways or Telepheriques, Barrett Guide-O-Matic Shuttle, Habegger Minirail, Inclines and Funicular Railways, Rack or Cog Railways, Westinghouse Transit Expressway, General Motors Continuously Moving Seats, Never-Stop Railway, Nippon Car-Lator, Stephens-Adamson Goodyear Carveyor, Goodyear People Mover, and Habegger Telecanape); Large Transit Vehicles (Bus & Trolleybus, All Service Vehicle, Guided Trolleybus, Gyrobus, Bus Rapid Transit, Cox Railbus and Fairmont Rail Bus, Chesapeake & Ohio Railvan, Guided Busway, Street Railways, Intermediate Rapid Transit, Rapid Transit Railways, Suburban Rapid Transit and Commuter Railways, Intercity Railroads, Duorail Rapid Transit, Duorail Coplanar Guideway, Safege Monorail, Alweg Monorail, Lartigue Monorails, Meigs Monorail, Palmer Monorails, New York and Brighton Monorail, Pegleg Monorail, Stone-Fairmont Park Saddle Monorail, Sierra Salt Monorail, Brennan Monorail, Scherl Monorail, AMF Monorail, Goodell Monorail, Langen Monorails, St. Paul Monorail, City Island Monorail, Bennie Railplane, Boynton Bicycle Railroad, Kearney High-Speed Railway, Kilmarnock Monorail, Senate Subway, Beach Pneumatic Subway, Pneumatic Postal Tubes, Bertin Aerotrains, Ford Levacar, General Motors Hovair, Inverted Hovercraft, Bachelet Solenoid Ring Railway, Girard Chemin De Fer Glissant, Rocket Sleds, Westinghouse Permanent Magnet Track, Freight and Postal Subways, "Sphero" Train, Transporter Bridges, Uniline, Air Cushion Vehicles, Ferryboats, Gyrocar, Hydrofoils, and Track Laying Vehicles).

NTIS Order #: PB-189-937
PC \$6.00, MF 95¢

Title: "Passenger Psychological Dynamics - Sources of Information on Urban Transportation, Report #3"

Author: Journal of Urban Transportation Corp.

Date: June, 1968

Proj. #: TRD-6

Keywords: 1. Ridership, attraction 5. Modal Split
2. Intermodal Competition 6. Time Costs
3. Surveys 7. Schedules and Scheduling
4. Community Response

Abstract: This report reviews consumer attitudes underlying modal choice in urban transportation, based upon an analysis of consumer attitude surveys and an examination of the results of several experimental mass transportation programs. In conducting this study, the authors have assumed: (1) The private automobile is widely available as an alternative to any other means of transportation; (2) Public transportation will be used by consumers if it meets their needs; and (3) Knowledge of the factors affecting modal choice can be useful in public facility planning and policy-making.

The modal choice factors of safety, reliability, time savings, cost, convenience, comfort aesthetics, and marketing and promotion that affect modal choice are analyzed in depth.

The authors found that safety in public transportation was once taken for granted, for mass transit's accident record has always been better than that of automobiles. But consideration of safety today includes exposure to assaults and robberies either on transit vehicles or during the gathering or distribution process. This factor is significant, as it inhibits off-peak patronage.

Time savings, tempered by cost considerations, is the crucial factor in the mode choice decision. If the common carrier runs frequently, a majority of workers choose it (to save time), but when the frequency drops down to every 15 minutes or less often, the proportion who use the common carrier drops from 50-60% to the range of 12-2%. It seems that riders will pay premium fares if they receive premium service.

NTIS Order #: PB-188-886
PC \$6.00, MF 95¢

Title: "Urban Transportation Planning-Sources of Information on Urban Transportation, Report #4"

Author: Journal of Urban Transportation Corporation

Date: June, 1968

Proj. #: TRD-6

Keywords: 1. Bibliographies 4. Land Use
2. Trip Generation 5. Quantitative Analysis
3. Computer, applications 6. Ridership

Abstract: This report is a review of the procedures followed in the comprehensive urban transportation planning process including a history of its development, trip generation and distribution methods, traffic assignment techniques, modal split determination, economic forecasting, and plan implementation problems. The appendix includes data and literature sources. Included also are technical reports on sources of information and state of knowledge reviews in urban transportation designed to give a general background on transportation to readers working in allied fields.

The methodology described in this report is a view of the transportation planning process as it exists in its current, most widely used form. Continuing research is underway in order to modify and improve various elements of the planning process, or to do away with it entirely and substitute new criteria for transportation planning.

Further work is necessary to enumerate, classify and evaluate efforts now underway all over the country. Additional efforts are attempting to refine and improve the basic models used to simulate the transportation environment; there is evidence to support the belief that the planning process improves if more quantifiable elements can be included in the models.

Not only the methodology, but also the scope of the planning process is changing. The projects refining the techniques of the transportation planning process range from the gathering of more accurate data inputs to redefining the parameters of transportation. The report notes that planning literature is voluminous. The author feels that in addition to this report, a readable and extensive summary of the new ideas evolving in transportation planning would be a valuable next step in a review of the transportation planning process.

The subject of trip generation is examined with reference to data sources, trip production, trip attractions, and trip generation techniques. Growth factor procedures (uniform factor method, average factor method, Fratar method, and limitation of growth factor methods) and synthetic models (gravity models, calibration of gravity models, limitation of gravity models, intervening opportunities models, inputs, and applications) of trip distribution methods are dealt with in depth, as are the inputs, network loading, impedance and travel time, design, and direct traffic estimation method of traffic assignment. In addition, the variables of the trip maker, the trip, and the transportation system are analyzed in the area of modal split. Economic studies and forecasts include trend line projection, step-down procedure, sector analysis, economic base multiplier method, input-output analysis, and economic goals. Plan implementation of urban transportation planning is discussed from the aspects of implementation tools (such as zoning, the official map, the capital program, and the review procedure) and the implementation itself.

NTIS Order #: PB-185-525
PC \$6.00, MF 95¢

Title: "A System to Facilitate Bus Rapid Transit on Urban Freeways: The Technical Feasibility of Using Traffic Surveillance and Control Techniques"

Author: John C. Glennon & Vergil G. Stover (Texas Transportation Institute)

Date: December, 1968 Proj. #: TRD-14

Keywords: 1. Bus, Priorities 5. Bus, Stations and Shelters
2. Bus, Costs 6. Construction, Cost
3. Vehicle, Monitoring 7. Traffic, Peak-Hour
4. Meters and Metering

Abstract: This report studies the technical feasibility of providing priority operation for buses on urban freeways by employing freeway surveillance and control. Under this Bus-Freeway System, the buses would be given priority access to the freeway via exclusive bus ramps; automobiles would be metered into the system in the quantities needed to use the excess capacity without jeopardizing the desired level of transit service.

Preliminary designs and cost estimates were prepared for four existing freeways. The study sites selected were: (a) The John C. Lodge Freeway in Detroit, Michigan; (b) The Gulf Freeway in Houston, Texas; (c) Interstate Route 35W in Minneapolis, Minnesota; and (d) The Penn-Lincoln Parkway (East) in Pittsburgh, Pa. The preliminary designs present the plan and profile of the existing freeway and show the necessary modifications for the Bus-Freeway System, including: (a) the location and type of each surveillance and control element, (b) the location and design of bus ramps, and (c) the approximate location of bus terminals.

The estimated costs of modifying the four study freeways for operation of a Bus-Freeway System are considered to be representative of the costs that might be encountered in converting other existing freeways or in constructing a Bus-Freeway System on new locations. These costs estimates include: (a) bus ramp construction costs, (b) bus terminal construction and right-of-way costs, and (c) the capital costs of the surveillance and control system. Cost estimates for all surveillance and control elements are for current (1967) prices based upon the cost of equipment and installation of the John C. Lodge and Gulf Freeway facilities operated by the Texas Transportation Institute.

Based on an estimate of the Bus Freeway System peak hour patronage, it was determined that each study site has an adequate "margin of safety" in satisfying the minimum amount of passenger diversion from freeway autos to buses. It was, therefore, concluded that the installation and operation of the Bus Freeway System is technically feasible and also practical for each of the four study sites.

NTIS Order #: PB-183-390
PC \$3.00, MF 95¢

Title; "Bus Rapid Transit on Urban Freeways Using Traffic Surveillance and Control"

Authors: Vergil G. Stover and John C. Glennon (Texas Transportation Institute)

Date: January, 1969

Proj. #: TRD-14

Keywords: 1. Bus, rapid transit
2. Bus, express
3. Traffic, peak-hour
4. Traffic, flow
5. Traffic, control
6. Speed and Speed Control
7. Private Transportation, automobiles
8. Traffic, congestion
9. Highway, planning
10. Modal Split

Abstract: Because of peak-period congestion on many existing freeways, travel speeds are considerably below that necessary to provide a true rapid transit service. Consequently, freeway express bus service is unable to attract a significant portion of the total peak-period passenger movement; as a result, the operation of buses on existing freeways cannot effect a substantial increase in the passenger movement capability. This report deals with the possibility of regulating entrance ramp volumes, by means of freeway surveillance and control, to insure a desired peak-period level of service. This concept, though proven successful for generally improving freeway flow, has not yet been applied to facilitate bus rapid transit operations.

The Bus-Freeway System is a rapid transit system in which the buses would operate in mixed traffic on a suburban freeway under the strict supervision of a traffic surveillance and control system. The control system would be operated to provide the main-line speed desired for bus transit operations. Under the most highly controlled conditions, the operation would be a true rapid transit system in which private vehicles would utilize the "unused capacity" between the transit vehicles.

Exclusive ramps would provide buses with an undelayed freeway entry; automobiles would be metered onto the freeway by ramp control. The metering rates would be regulated to maintain the volume on each freeway section at or below that necessary to achieve the desired level-of-service; automobiles would be stopped at the entrance ramps and allowed to enter the freeway only when their presence would not jeopardize the desired level-of-service. Although automobiles would be delayed on the entrance ramps, the authors do not feel that the delay would exceed that experienced with freeway congestion under uncontrolled conditions. Buses would have a greatly reduced terminal-to-terminal travel time and the authors express belief that this improved level-of-service for buses should generate sufficient patronage to effect a substantial increase in the passenger movement capability of the freeway.

With the existing technology of freeway surveillance and control, the functional control requirements of the Bus-Freeway System are technically feasible; however, for the system to improve both the level-of-service and the passenger movement capability of the freeway, the authors state that there must be a maximum passenger diversion from freeway automobiles to buses.

Since the economic feasibility and public acceptance potential of the Bus-Freeway System require further investigation, the authors recommend that a demonstration project be undertaken to ascertain these aspects of the system.

NTIS Order #: PB-183-330
PC \$3.00, MF 95¢

Title: "A System to Facilitate Bus Rapid Transit on Urban Freeways: The Technical Feasibility of Using Traffic Surveillance and Control Techniques -- Appendices"
[OVERSIZE DOCUMENT]

Author: John C. Glennon and Vergil G. Stover (Texas Transportation Institute)

Date: December, 1968

Project No. TRD-14

Keywords: 1. Bus, rapid transit 4. Traffic, control
 2. Bus, busway 5. Maps and Mapping
 3. Highway, planning 6. Access, planning and control

Abstract: The report is a collection of maps and related graphics outlining the proposed configuration of access and exit ramps for four freeways. The material is presented as appendices to other reports generated by TRD-14 which concern traffic control systems to facilitate bus rapid transit on urban freeways. The four preliminary plans outlined in this report include: (1) the John Lodge Freeway in Detroit, (2) the Houston Gulf Freeway, (3) Minneapolis Interstate Route 35W, and (4) the Penn Lincoln Parkway in Pittsburgh.

The maps denote individual freeway segments, gradation, entry and exit points, and positioning of traffic surveillance and control apparatus.

NTIS Order #: PB-183-391
PC \$3.00, MF 95¢

Title: "Cleveland-Hopkins Airport Access Study: Survey Results"

Author: Regional Planning Commission, Cuyahoga County, Ohio

Date: June, 1970

Proj. #: TRD-36

Keywords: 1. Airport, access
2. Surveys
3. Ridership, profiles
4. Center City
5. Modal Split
6. Trip Generation
7. Rail, commuter

Abstract: The report summarizes results obtained in the Cleveland Hopkins Airport Access Study. The project attempted to assess the impact of providing rapid rail transit service between the Cleveland central business district and Hopkins' Airport, particularly with reference to modal split and ridership characteristics. Two separate surveys of airport users were correlated, representing characteristic ridership profiles by mode both before and after the transit link became operational.

The report outlines data collected concerning overall airport activity and transit ridership; characteristics of air passengers, air trips, and ground trips to the airport; passenger-related visitors; airport employees; and casual visitors. The report also details complete statistical material and sample copies of all survey questionnaires distributed among the before-and-after samples.

Several findings were identified as highlights of the report. (1) Nearly 58% of all transit riders were air passengers, and only 1/4 of this group began their trips in the Cleveland central business district. (2) Approximately 14.5% of all air passengers at Hopkins Airport used the rapid transit for airport access. More significantly, at least 25% of all air passengers with origins or destinations in the rapid transit service area used the system. (3) The opening of the transit extension resulted in ridership declines for private automobiles, limousines, and taxis. All modes of travel indicated some ridership diverted to the rapid transit. (4) Transit use rose to more than 30% among air passengers traveling to or from terminals of the rapid transit system. (5) Only about 8% of all airport employees utilized public transportation for work trips prior to the opening of rapid transit service. "After" studies revealed that as many as 18% expressed the intent to make frequent use of the transit extension. (6) Transit was also used by small percentages of passenger-related and casual airport visitors, two groups which were previously almost exclusive users of private automobiles.

The report was prepared as a summary of more detailed raw data which appear along with descriptions of survey methodology in separate documents generated by TRD-36.

NTIS Order #: PB-195-045
PC \$3.00, MF 95¢

Title: "Cleveland-Hopkins Airport Access Study: Data File Editing & Preliminary Analysis"
"Cleveland-Hopkins Airport Access Study: Data File Formats and Code Descriptions"
"Cleveland-Hopkins Airport Access Study: Selected Tabulations, Air Passenger Study"

Author: Regional Planning Commission, Cuyahoga County, Ohio

Date: May and June, 1970

Project No. TRD-36

Keywords: 1. Airport, access
2. Computer, programming
3. Codes and Coding
4. Quantitative Analysis
5. Surveys
6. Modal Split
7. Ridership, profiles

Abstract: The three reports document quantitative methods for analysis of survey data collected in the Cleveland-Hopkins Airport Access Study. The purpose of this study was to assess a new rail rapid transit extension between the Cleveland central business district and Hopkins Airport with reference to its impact on modal split and ridership. Statistical data on airport access by air passengers, passenger-related visitors, casual visitors, and airport employees were collected in two surveys taken before and after the commencement of transit operations.

The "Data File Editing" report documents procedures used in producing and editing the survey material and in developing expansion factors. The principal objective of this report was to mathematically expand the survey sample data into reliable estimates about the entire population of airport users. Coding process, data editing procedures, survey response rate, and subsequent expansions of the sample are detailed for the surveys of air passengers, employees, and casual visitors. Some preliminary analysis of the data is provided through comparisons of air passenger survey results with rapid transit interviews. Expanded survey results are reproduced along with sample questionnaires and selected data file formats and keypunch instructions.

The "Data File Formats" report outlines in detail the specific coding descriptions for all surveys in both phases of the study. The purpose of the report is to document actual programming procedures used to analyze the data. Appended material includes airport maps showing the survey locations and sample questionnaires.

The "selected Tabulations" report reproduces actual computer printouts of significant survey data. The tabulations break down two general areas of major interest to the project sponsors: (1) mode of travel by local origin or destination and selected characteristics of the air passenger and his trip; and (2) transit station by residence of air passenger and direction of travel for selected characteristics of the air passenger and his trip. Appended material includes traffic centers and census tracts in the survey area, rapid transit stations, and sample questionnaires.

The three reports together document the handling of survey data. Collection procedures and survey results are outlined in other reports generated by TRD-36.

Index No. 3-00-36.5

NTIS Order #: PB-195-047
PB-195-048
PB-195-049

Index No. 3-00-36.4

Each Volume: PC \$3.00, MF 95¢

Index No. 3-00-36.3

271

Title: "A Preliminary Report on the Cleveland Before and After Study"

Author: George F. Wiggers (U.S. Department of Transportation)

Date: May, 1969

Proj. #: TRD-36

Keywords: 1. Surveys 3. Ridership , profiles
2. Airport, access 4. Trip Generation

Abstract: This report describes the Cleveland Before and After Study which was initiated by the Department of Transportation for the purpose of obtaining demand information on rapid transit service. The Cleveland Transit System (CTS) owned by the City of Cleveland operates both buses and a rail rapid transit system within Cleveland. The rapid rail was opened in 1955 and is currently operating over 19 miles of track, including the recent four mile extension to Hopkins Airport. The Department of Transportation is currently completing the processing of the "before" data and has begun preparation for the "after" data collection.

An extensive survey was conducted as part of the before phase of the study at Cleveland's Hopkins Airport during the week of September 8-14, 1968; in all, 33,126 air passengers, 1,866 airport employees, and 541 casual visitors responded. A data tape was developed from these responses of the air passenger and employee groups, and an analysis has been conducted regarding trip purpose, local origin and destinations, and baggage checked.

The air passenger data consisted of 33,102 responses which were collected on-board flights arriving and departing Cleveland. Stewardesses distributed and collected questionnaires while the plane was in-flight, and the airline traffic managers routed the questionnaires to the appropriate flights and back to the Hopkins Airport to be then retrieved by the Department's contractor. The employee survey resulted in 1,866 responses from an estimated 3,160 employees working at Hopkins Airport during the survey week. This group is comprised of all regular airport employees, including airport management, airline personnel (except crew members), FAA control staff, concession employees and porters.

Within the limited amount of data available at this stage of the study, it has been estimated that: (1) 71-80% of the people boarding the CTS rapid at the airport are air passengers. (2) More than 65% of the air passengers going between the airport and some suburban Cleveland areas appear to be using the rapid rail. (3) A large number of air passengers are willing to ride two transit systems, the CTS and the Shaker Rapid, making as many as 25 local stops and one transfer on their trips to and from the airport. (4) A relatively small percentage (10.3%) of the air passengers originating or terminating in the Cleveland area begin or end their trips in the Cleveland Central Business District. (5) Because of the current number of air passengers using Hopkins Airport, the impact of the rapid on reduced congestion of highway facilities at the airport is only marginal.

NTIS Order #: PB-184-060
PC \$6.00, MF 95¢

Title: "Evaluation Procedures for Poverty Transportation Projects -- Phase I:
Summary Report"

Author: John L. Crain (Stanford Research Institute)

Date: April, 1970

Proj. #: TRD-41

Keywords:	1. Employment	6. Social Benefits and Costs
	2. Inner City	7. Ridership
	3. Poverty	8. Industrial and Labor Relations
	4. Benefit-Cost Analysis	9. Government, Federal
	5. Quantitative Analysis	10. Race

Abstract: The report develops an evaluative model for Federally-assisted programs designed to provide employment-oriented transportation for the poor. The objective of this research was to provide an objective tool for benefit-cost analysis of such projects.

The Service Development Grants (SDG) program is examined generally as an instrument to improve inner city employment by providing transportation to job opportunities outside the core cities. The report seeks to apply standardized evaluative criteria to measure the effectiveness of such projects in the aggregate. Several limitations to the SDG program are outlined, principally to suggest that specific factors pertinent to an individual project may affect its outcome and may not be highlighted in the benefit-cost analysis. These problems include: (1) relationship to national economic health (ie. Transportation-employment projects yield optimum results only when national unemployment and other statistics fall within a given range); (2) long commute distances without adequate commensurate wages; (3) marginally effective labor force; (4) racial discrimination; (5) shrinking low-skill labor market; (6) conversion to automobile transportation by workers as they accumulate savings; and (7) labor protective legislation which restricts the concepts which SDG programs can test.

Appended material documents all relevant aspects of the benefit-cost model with reference to its development and implementation. The empirical equation in its simplest terms permits project supervisors to compare benefits (measured by riders' increased earnings) with costs (measured by net operating expenditures). Although the author notes that indirect benefits (measured by reduced crime and welfare costs, and increased labor production and tax revenues) are difficult to quantify, the model does provide for an estimate of such variables which are essential to the accurate determination of success.

The report also includes a model for measuring attrition among overall ridership within the general benefit-cost analysis. That is, during the period covered by an SDG program, it may be as important to examine those riders who stopped using special transportation as those who were brought in. Other appendices discuss guidelines for SDG survey instruments, transportation systems for ghetto areas, minority-ownership of poverty transportation systems, highlights of a 1969 seminar on employment-related transportation programs, and a model for estimating the wages required to induce commutation between inner cities and suburban job opportunities. The empirical model for evaluating SDG projects is also outlined in detail.

NTIS Order #: PB-200-552
PC \$3.00, MF 95¢

Title: "The Reverse Commute Experiment (A \$7 Million Demonstration Program)"

Author: John L. Crain (Stanford Research Institute)

Date: December, 1970

Project No. TRD-41

Keywords: 1. Bus, commuter
2. Lane, reserved
3. Corridors
4. Inner City
5. Employment
6. Suburban *mobility*
Reverse Commute

7. Benefit-Cost Analysis
8. Quantitative Analysis
9. Routes and Routing
10. Surveys
11. Ridership, volume
12. Government, urban

Abstract: The report examines the operational and economic feasibility of public transportation connecting inner city areas with suburban job opportunities. In this context, the city-to-suburb transit service is referred to as "reverse commute."

In an effort to relieve the problem of the unemployed inner city worker, or the potential worker without private transportation, 14 cities sponsored demonstration tests that in total or in part concerned reverse commute service development. One specific project, the Chicago O'Hare express, demonstrated an express bus service connecting Chicago's rapid transit system with the O'Hare Airport employment center. This project embodied every positive accomplishment that was desired of the service development program. Route development for each of the fourteen cities is reviewed and the success or failure evaluated. The success of a project does not necessarily mean that the deficit was reduced to zero, only that it was reduced to a small enough loss for local agencies to place it into a permanent operating status. The author notes that when a project is showing a deficit, it does not necessarily mean that a true loss would occur should the project be integrated into the total metropolitan transit system.

The benefit-cost model used was designed to circumvent difficulties by producing highly conservative answers so that the minimal values obtained would have greater credibility. The two types of benefits measured were income benefits (ie. added income to inner city residents resulting from suburban employment) and savings in time and cost to transit users. Surveys were made of the estimated benefits, how they divided between income and user benefits, and of operational deficits in six of the 14 demonstration cities.

All aspects of the program are summarized with reference to: (1) social benefits, (2) route development, (3) other developable reverse commute routes, (4) bus patronage attrition, (5) viable routes to serve multiple user groups, (6) merchandising of transit to minority groups, (7) overall effectiveness of the service development grant program, (8) project successes, (9) involvement of the transit industry, and (10) institutional constraints (eg. labor protection, fragmentation of regional systems, and general transit deficits).

The author concludes that the major objectives of this demonstration program have been met. The 14 reverse commute projects, on the basis of benefit-cost analysis, were judged to have satisfied the basic criteria of providing job opportunities and increased mobility for inner city dwellers. The report recommends that to have experimental value, further demonstrations should embrace non-conventional systems and/or new approaches to financial subsidies.

NTIS Order #: PB-199-400
PC \$3.00, MF 95¢

Index No. 3-00-41.2

274

Title: "Comprehensive Planning for Metropolitan Development"

Author: Washington Center for Metropolitan Studies

Date: 1970

Proj. #: TRD-42

Keywords: 1. Government, Urban
2. Government, State
3. Government, Federal
4. Government, Intergovernmental Relations
5. Government, County
6. Urban Development, Planning
7. Urban Development, Renewal
8. Highway, Planning
9. Housing
10. Land Use

Abstract: The report is a literature survey of comprehensive planning for metropolitan areas with particular emphasis on the planning process. The authors note that although the existence of metropolitan planning bodies is frequently a desirable prerequisite for Federal grants-in-aid, the processes under which these agencies operate are subject to significant variations in comprehensiveness of impact and other effectiveness criteria. One major, recurrent theme in the report is how metropolitan planning is applied to urban development patterns; that is, the degree to which planning bodies can control or influence overall development of the metropolis.

The report begins with a general analysis of fundamental issues and concepts in metropolitan planning, such as its evolution from city planning, non-physical development, the relationship between planning and politics, and planning as a process. A brief discussion of the historical evolution of metropolitan planning follows developments through the New Deal era and post World War II, culminating with events of the last decade.

The impact of Federal policy on the planning process is a subject of major concern. The authors examine "benchmarks" in the growth of Federal policy and analyze more than a dozen major pieces of Federal legislation in the areas of housing, highway construction, Model Cities, and mass transportation. Federal requirements for urban planning are a focal aspect of this analysis.

The report also discusses the intergovernmental relationships in metropolitan planning. The authors examine existing Metropolitan Planning Commissions in terms of enabling legislation, organization, staffing, financing, and program outputs. Councils of Government are analyzed in terms of their coordinative role and demonstrated abilities. The Metropolitan Council model is also examined as a possible new institution in the jurisdictional patchwork of urban government. Finally, the states' role in metropolitan planning is discussed in the particular cases of Connecticut, New York and New Jersey.

The political aspects of comprehensive planning are treated with reference to: power distribution in the metropolis; political systems in urban government; the clash between functional interests and comprehensive planning objectives in land use, housing, transportation, and social services; and strategies of planning which employ information output, monopoly of technical expertise, and integration of the metropolitan leadership. An overall evaluation of contemporary metropolitan planning is included.

Finally, the authors conclude with an assessment of current pressures and emerging trends along with recommendations for future Federal policy. Of particular concern are the ambivalence of present legislation, the role of State government, the conflict between centralization and decentralization, and the need for increased citizen participation in the planning process.

NTIS Order #: PB-200-135
PC \$3.00, MF 95¢

Title: "Baseline System Definition of the Aerial Transit System"

Author: Aerial Transit Systems, Inc. (for Johns Hopkins University, Applied Physics Laboratory)

Date: January, 1970

Proj. #: TRD-43

Keywords:	1. People Mover, Aerial Transit System	6. Vehicle, design
	2. Aerial Structures	7. Rail, system planning and design
	3. Airport, access	8. Safety
	4. Guideways	9. Construction, cost
	5. Rail, stations and terminals	10. Switches and Switching
		11. Speed and Speed Control

Abstract: The report is a baseline description of the Aerial Transit System (ATS), an innovative mass transportation concept designed for high-speed (up to 200 mph), point-to-point service in an urban setting. The system employs lightweight vehicles propelled along a flexible steel guideway which is supported by cables suspended from towers spaced 1/4 mile apart. The report examines all relevant aspects of ATS operations in a hypothetical application for access to Kansas City International Airport from the central business district. Although many design specifications outlined in the report pertain to this specific case study, the authors note that the ATS is sufficiently flexible to permit its application in many urban areas.

System design and performance of the ATS is analyzed with reference to all operational characteristics and technical features. The report covers station capacity and spacing; guideway capacity, switching, and curvature; vehicle performance; system control, headway and communications; passenger comfort; vehicle safety and maintenance; and security. Technical considerations provide a detailed examination of vehicle design, suspension, propulsion, braking, speed control, and power requirements. The guideway structure is also discussed with reference to rail alignment, switching, station design, vehicle monitoring, station interface and fare collection, routes and schedules, and management requirements. A final section of the report outlines a recommended program of additional research and demonstration, emphasizing testing of scaled prototype systems. Appended material provides supplementary analysis of the propulsion and auxiliary systems of electrical power distribution for the ATS.

Several major advantages of the ATS over conventional rapid transit designs are highlighted by the report, including: (1) safety (ie. The vehicle can be stopped and recovered easily in cases of malfunction, cannot jump the track, and is generally secure from vandalism.); (2) non-pollution; (3) ease of installation or relocation, particularly where ATS application is intended to stimulate or control urban growth patterns and real estate development; and (4) speed of installation. In addition, the authors advance four cost advantages of ATS versus conventional rail systems, including: (1) the availability of land beneath the rights-of-way for productive utilization; (2) the elimination of many site preparation costs; (3) component unit costs that compare favorably with other vehicle guideway designs; and (4) the opportunity for direct point-to-point routes (eg. airport access) with which existing ground features will not interfere.

NTIS Order #: PB-192-733
PC \$3.00, MF 95¢

Title: "Alden Capsule Transit System and Control Subsystem and Baseline Definition"

Author: Alden Self-Transit Systems Corporation (for Johns Hopkins University, Applied Physics Laboratory)

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. People Mover, Alden StaRRcar 6. Rail, automatic control
2. Personal Rapid Transit 7. Rail, stations and terminals
3. Guideways 8. Rail, systems planning and design
4. Vehicle, design 9. Switches and Switching
5. Freight Movement 10. Noise and Noise Control

Abstract: The report is a baseline description of the Alden Capsule Transit System (ACTS), an innovative urban mode for personal rapid transit. The system employs small vehicles (less than six passenger capacity) called StaRRcars which operate over automated guideway structures between stations. Each capsule is individually programmed by its passengers to provide direct point-to-point service within center city areas, medium and high density suburbs, new towns, or other major activity centers. The automatic control subsystem permits variable headways and flexible demand-responsive service during peak periods. The purpose of the report was to provide a baseline description of the system components, rather than performance characteristics of the unified configuration.

The subsystem analyses are broken down among: (1) control system, (2) vehicle, (3) guideway structure and configuration, (4) stations, and (5) operating support requirements. All technical and engineering aspects of the automatic controls are examined with reference to vehicle speed and headway maintenance, propulsion control, communications, computer hardware, station control electronics, route selection control, safety and emergency features, and the guideway/control interface. Description of an ACTS prototype testing facility is also provided.

The vehicle design is outlined in detail with reference to basic considerations and specifications. The authors note that the overall system can be modified to either handle larger vehicles (approximately 16 passenger capacity) in linehaul service or to move freight and cargo. The guideway configuration is also described with reference to structures, environmental protection considerations, and electrical subsystem. The report focuses particular attention on the switching mechanism which permits vehicles to move from stations into the main guideway stream. Stations are also discussed briefly along with general support operations which include maintenance, facilities other than stations, and manpower.

Four possible system applications are discussed with reference to requirements for station spacing, estimated speeds, and vehicle capacity. These applications cover: (1) a central business district, (2) intermodal connection passing through a residential area, (3) connection with a major activity center, and (4) park circulation and connector functions. Six specific system benefits are outlined with reference to air and noise pollution control, safety, reliability, economic operation, and service quality.

Appended material includes analyses of noise suppression by the ACTS, steering dynamics, station design considerations, and formulas for determining optimal station capacity.

NTIS Order #: PB-192-737
PC \$3.00, MF 95¢

Title: "Dashaveyor Transit and Cargo Systems, A Baseline Definition"
Author: The Dashaveyor Company (for Johns Hopkins University, Applied Physics Laboratory)
Date: May, 1970 Proj. #: TRD-43

Keywords: 1. People Mover, Dashaveyor 6. Topography
2. Guideways 7. Vehicle, design
3. Freight Movement 8. Rail, systems planning and design
4. Materials Handling 9. Vehicle, monitoring
5. Personal Rapid Transit 10. Propulsion Systems, electric
11. Computer, applications

Abstract: The report is a baseline description of the Dashaveyor transit system, an innovative "total transportation" concept designed to meet a wide variety of requirements for urban people and goods movement. Although developed initially to satisfy unusual requirements in the field of bulk materials handling, the Dashaveyor as described by the authors can incorporate modifications to permit the transporting of people, containerized freight and supplies, or mail in an urban situation. The report gives particular attention to the potential design of an integrated Dashaveyor transport system capable of simultaneous people, freight, and bulk materials movement.

The system consists of electrically powered, automatically controlled small-vehicles operating above a dual rail guideway structure. Different transportation requirements can be satisfied by varied combinations of guideway designs, propulsion units, vehicle configurations, and automatic control functions. The report notes flexibility in design of all components to permit operation at or above grade, and at high speeds over level terrain or moderate speeds for climbing steep grades. Automatic controls could also be modified for scheduled, on-call, or manual operation. The report describes Dashaveyor service within the hypothetical requirements of Nimbus, U.S.A.

Separate analyses of the Dashaveyor configuration are provided for its different applications. As passenger transportation, the system is designed primarily for intra-city operation, particularly as a feeder system for larger-capacity corridor operations. The authors note that Dashaveyor may be an especially attractive airport access mode. The passenger application is centered on personalized service emphasizing high average rather than high maximum (50 mph.) speed for vehicles with capacities ranging from 6 to 48. As transportation for bulk material, Dashaveyor was designed initially for mining applications where cargo could be transported without requiring intermodal transfer. One particular advantage in this context is that the guideway is operable at any grade (including vertical). Besides the use of Dashaveyor systems to transport mined ore, the authors note its ability to move all forms of solid wastes from industrial and sewage treatment facilities. As cargo transportation, the report examines intra-urban movement of baggage, freight, and mail by Dashaveyor.

All aspects of the system are examined in detail with reference to operational and technical characteristics of the hypothetical design for Nimbus, U.S.A. System performance and human factors are evaluated in terms of vehicles, guideways, stations, and security. Technical characteristics of vehicle propulsion, guideway specifications, system design, automatic computer control, and a thorough breakdown of estimated costs are examined in detail. Appended material documents installation specifications, DC propulsion, vehicle aerodynamics, power requirements, circulation capabilities, and control communications.

NTIS Order #: PB-192-734
PC \$3.00, MF 95¢

Title: "General Electric Aerial Transport System, A Baseline Definition"
Author: General Electric Company, Transit Systems Department (for Johns Hopkins University, Applied Physics Laboratory)
Date: May, 1970 Proj. #: TRD-43

Keywords: 1. People Mover, General Electric Aerial Transport
2. Aerial Structures
3. Guideways
4. Suspension
5. Airport, access
6. Wheels
7. Brakes and Braking
8. Rail, systems planning and design
9. Vehicle, design
10. Speed and Speed Control
11. Propulsion Systems, electric
12. Propulsion Systems, linear induction

Abstract: The report is a baseline description of the General Electric Aerial Transport System (GEATS), an innovative concept for station-to-station mass transportation along a fixed network of specially constructed "beamways" in an urban situation. The authors note particularly the flexibility of GEATS configurations to provide variable speeds, headways, and passenger accommodations as required by specific applications. The system utilizes a unique suspension concept in which vehicles are connected to rubber-tired, electrically powered trucks running within an enclosed beamway structure. An airport access application was selected as the baseline description of a typical GEATS configuration. The authors note, however, that flexibility of the system can permit simple adaptation to other urban mass transportation requirements.

The GEATS is essentially a modification of the SAFEGE system in France, where the feasibility of utilizing rubber tires for rapid transit vehicles was first demonstrated on the Paris METRO. The report documents extensive testing of the SAFEGE concept with reference to safety, vehicle stability, and ride quality. The authors also discuss demonstrations of similar vehicles in Japan and elsewhere. Several advantages of the GEATS design are highlighted, including: (1) limited lateral swinging movement of the coach body; (2) ease in negotiating curves; (3) significantly reduced noise levels (due to the beamway design); and (4) improved vehicle performance relative to passenger comfort, track adhesion, and overall maneuvering afforded by the use of pneumatic rubber tires.

The report examines in detail all relevant aspects of GEATS operation and technical characteristics. System performance is evaluated with regard to stations, guideway structures, vehicles, and overall system control. Passenger comfort criteria are developed and compared with performance specifications; emergency and environmental considerations are also discussed. Technical aspects of the system are examined in terms of vehicle dynamics, propulsion and braking, guideway configuration and support structures, stations and fare collection, automatic train control, and maintenance and administration.

Finally, the report examines potential adaptations of the baseline system for high-speed and small-vehicle applications. Present speeds are restricted to less than 150 mph because of the rubber tires and limited capacity of the mechanical braking system. The authors recommend demonstration of a GEATS powered by linear induction motors to achieve higher speeds. The authors also conclude that the GEATS would be particularly effective when adapted to move small-vehicles (less than 10,000 passengers/hour capacity) over short distances within a dense urban area.

NTIS Order #: PB-192-732
PC \$6.00, MF 95¢

Title: "Scherer Monobeam Suspension Concept of Mass Transportation"
Author: Scherer Monobeam Company (for Johns Hopkins University, Applied Physics Laboratory)
Date: May, 1970 Proj. #: TRD-43

Keywords: 1. People Movers, Scherer Monobeam 6. Rail, systems planning and design
2. People Movers, monorail 7. Vehicle, design
3. Rail, cost 8. Aerial Structures
4. Rail, rolling stock 9. Switches and Switching
5. Rail, stations and terminals 10. Noise and Noise Control

Abstract: The report is a comprehensive performance and design profile of the Scherer Monobeam transit system, prepared by its manufacturer. The Monobeam represents an innovative adaptation of suspended monorail technology for application both in high-speed rapid transit and in lower-speed urban service. The Monobeam was designed in an effort to eliminate the undesirable features of conventional monorails such as uncomfortable ride, car swaying, high noise production, aerodynamic buffeting of cars passing fixed structures, and prohibitive costs associated with construction and maintenance. The report suggests that refinements in state-of-the-art have substantially reduced these undesirable qualities in the present system.

The Scherer Monobeam employs a single track structure from which vehicles are suspended on both sides to permit simultaneous linear travel in opposite directions. The unique feature of the concept is the positioning of the rails in a vertical rather than a horizontal plane which relocates the center of gravity to help control oscillation, weaving, and swaying of the cars.

Performance and design specifications of the Monobeam system are described both as the concept relates to rapid transit and to application within a central business district. The suspension structure, rails, cars, propulsion unit, switching capability, and other features are examined in detail. Textual material is supplemented with comprehensive statistical data and graphic displays. The report also includes preliminary cost estimates for both structures and rolling stock based on alternative materials. Costs of a proposed Scherer Monobeam prototype and 2-mile demonstration facility are outlined.

Appended material consists of artists' conceptions of the system, stations, and vehicle interiors.

NTIS Order #: PB-192-729
PC \$3.00, MF 95¢

Title: "Sky-Kar Transivator System: A Baseline Definition"

Author: Sky-Kar Corporation (for Johns Hopkins University, Applied Physics Laboratory)

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. People Movers, Transivator 5. Flanges
2. Guideways 6. Speed and Speed Control
3. Computer, programming 7. Demand-Responsive Systems
4. Computer, applications

Abstract: The purpose of this report is to describe and define the Sky-Kar Transivator system, a short-haul, horizontal People Mover. The Transivator is composed of three basic components. The vehicles, referred to as Kars, are primarily designed for the comfort of the passengers, to maintain the personalized environment of automobiles; the Kars are self-powered and operate automatically. The Guideway, a wide flange I beam, is suspended below supporting stanchions, ceilings, and other members designed to hold the guideway beam at an elevation sufficient to allow the Kars to travel beneath the super-structures. The controls, that segment of the system which performs the automation functions, depended for research and design upon the most modern technical information available; the author says that the control systems are the brains of the Transivators. Computers and electronic devices are employed to the extent required by any given system; the larger, more complex systems require more sophistication in control operation, while the smaller systems can be modified and tailored to meet less complex requirements.

The vehicle will have a capacity for twelve passengers (six seated and six standing); no provisions are made for baggage. Studies of automatic elevators of similar capacities show an average of eight seconds unloading time and ten seconds loading time; preliminary plans for Sky-Kar are based on times of 15 seconds for loading and fifteen seconds for unloading. The motor control system will be programmed for automatic acceleration, deceleration, line speed, merge speed, and a very slow speed (referred to as "creep"); the creeping movement of the Kar is used to position the vehicle accurately at the loading gate, permitting the Kar to stop with no pronounced braking or sudden arrest of its forward movement. Programmed acceleration is accomplished by a set ramp function generator and velocity feedback from the motor; with close control over the feedback system, jerk is expected to be minimal and unnoticeable.

Kars, to operate in a loop, will function much like automatic elevators; a call from a station will divert the next partially loaded Kar to that station. Passengers will have coded tickets to designate destinations or, if tickets are not used, buttons installed in the vehicles will be used to identify destinations. Information as to Kar numbers and locations is fed to the Control Central Station; however, Kars are under the control of the individual stations during the time they are in that area.

NTIS Order #: PB-192-727
PC \$3.00, MF 95¢

Title: "Transportation Technology Distribution System for a High Density Urban Area, a Baseline Definition"

Author: Transportation Technology, Inc. (for Johns Hopkins University, Applied Physics Laboratory)

Date: May, 1970

Proj. #: TRD-43

Keywords:	1. Distribution Systems	6. Switches and Switching
	2. Propulsion Systems, linear induction	7. Rail, systems planning and design
	3. Guideways	8. Rail, rolling stock
	4. Air Cushion Vehicle	9. Rail, stations and terminals
	5. Suspension	10. Personal Rapid Transit
		11. Computer, applications
		12. Power Distribution

Abstract: The report outlines the baseline description of a proposed innovative mass transportation mode under development by Transportation Technology, Inc. The system employs linear induction motors to provide propulsion and air cushion suspension for small passenger modules travelling over a fixed guideway for distribution service within high-density urban areas. The vehicles are automatically controlled by a central computer unit to permit scheduled operation (using 12-passenger modules) and personal, demand-responsive service (using 6-passenger modules). All vehicles operate on the same guideway; stations are designed to move the modules laterally from sidings into passenger loading positions.

The baseline description is outlined within the context of a specific urban case study, emphasizing applications for high-density areal distribution and access between the central city and a peripheral parking zone. The report provides a detailed description of the urban area in which the system was studied. The study area contained approximately 6.7 miles of guideway among 11 stations over which vehicles moved at speeds of between 20 and 60 mph.

All relevant aspects of system concept, operational characteristics, and engineering are examined. These include: system attributes, vehicle design, guideways and stations, component technologies, system performance, human factors, emergency and environmental considerations, vehicle technology, propulsion and braking, suspension systems, automatic control, maintenance requirements, and system reliability.

The report is concerned primarily with demonstrating conceptual feasibility rather than with advancing a specific system configuration. Particular attention is given to flexibility of the design for application in a variety of urban situations with different transportation requirements. The authors consequently advance **six** aspects of the overall system design which offer the greatest promise for future technological improvement. These include: (1) linear induction propulsion and related braking, switching, and docking systems; (2) power pickoff and energy storage; (3) station and guideway configuration; (4) vehicle design and passenger comfort; (5) information display; and (6) communication command and control.

As an indication of the flexibility with which the design can be employed, the report outlines briefly 10 advanced systems which may evolve from the baseline, given sufficient technological development. These cover a wide variety of applications ranging from high speed mass transportation to personal rapid transit, and speeds of between 20 and 300 mph.

NTIS Order #: PB-192-739
PC \$3.00, MF 95¢

Title: "Baseline System Definition: Urban Gravity-Vacuum-Transit"

Authors: L. K. Edwards and B. E. Skov (Tube Transit Corporation)

Date: May, 1968

Proj. #: TRD-43

Keywords: 1. Tubes and Tube Vehicle 3. Speed and Speed Control
 2. Tunnels and Tunneling 4. Pneumatics

Abstract: This report discusses the details of the construction and operation of the proposed urban Gravity Vacuum Transit system (GVT). Cylindrical, pressure-tight trains travel through a pair of steel tubes in underground tunnels, which dip between stations to depths as great as 2000 feet. These tubes are evacuated by electrically-powered pumps or compressors located near the stations. The "Baseline System" described in this report reflects a configuration that is considered to be best suited for very large cities (populations above two million people).

The GVT concept employs gravity for roughly 70% of its total energy requirement and atmospheric air for the remaining 30%. By accelerating passengers at a rate much higher than they feel, it permits average speeds roughly twice that of present-day urban transportation systems. At any arbitrary acceleration comfort level, GVT permits effective speeds substantially higher than the theoretical limit for horizontal transportation systems with stage lengths of less than 10 miles.

The basic GVT stage consists of two stations housed within an evacuated tube. The tube curves downward for gravity boost between stations. There are valves at each end of the evacuated tube to allow the train to enter and exit. At the outset, the train is at rest in station A, surrounded by normal atmosphere. Valves A and B are closed and the tube is evacuated to approximately 1/40 atmosphere. The trip is initiated by opening valve A. With near-vacuum ahead and atmospheric pressure behind, the train accelerates into the tube and down the slope, gaining kinetic energy from gravity and air pressure. When a predetermined amount of pneumatic energy has been imparted to the train, valve A is closed by command from the central computer. As the train continues on, the air "slug" between the train and valve A expands, imparting additional energy to the train; the thin air ahead is gradually compressed. Acceleration of the train, high at the beginning of the trip, slowly decays until the pressure ahead exceeds the pressure behind. Thereafter, the train decelerates at a progressively increasing rate. As the train approaches station B, it travels up the slope, losing kinetic energy to gravity and compression of air ahead. When the air ahead reaches atmospheric pressure, valve B automatically opens and the train pushes air ahead out into the atmosphere. With atmospheric pressure ahead and near-vacuum behind, the train rapidly decelerates to a stop in station B; valve B automatically closes immediately after the train passes through. The trip is completed with the train at rest in station B, again surrounded by normal atmosphere. Pressure in the tube is now approximately 1/20 atmosphere. The tube is readied for the next trip by pumping out sufficient air to reduce the pressure to the original level of 1/40 atmosphere.

The speed attributable to gravity depends on the depth between stations. The greatest depth proposed for Urban GVT is 2000 feet, which imparts a speed of 245 mph. A depth of 1000 feet accounts for 175 mph. The evacuated tubes between stations are separated from the station proper by means of larger valves through which the trains can pass. A pneumatically actuated and pneumatically counter-balanced valve is proposed for this application. When operating as an entry valve, it opens on command to admit the train and closes on command behind the train.

NTIS Order #: PB-179-157
PC \$6.00, MF 95¢

Title: "Gravity-Vacuum Transit System, Baseline Definition of Airport Access and Corridor Systems"

Author: Tube Transit Corporation (for Johns Hopkins University, Applied Physics Laboratory)

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. Tubes and Tube Vehicles 5. Pneumatics
 2. Corridors 6. Rail, rolling stock
 3. Airport, access 7. Tunnels and Tunneling
 4. Speed and Speed Control 8. Suspension

Abstract: The report describes Gravity-Vacuum Transit (GVT) systems for airport access and corridor (defined as intercity) applications. This concept employs the combined forces of gravity and atmospheric air pressure for propulsion of trains through evacuated underground tubes. The report focuses specifically upon modifications of the basic urban transportation GVT design for operation in airport access and corridor services which require longer stages and higher speeds.

The GVT configuration employs a pair of steel tubes in a tunnel that dips between stations so that gravity assists in accelerating and decelerating the trains. These tubes are evacuated by electrically powered pumps and the cylindrical, pressure-tight trains are accelerated and decelerated by atmospheric pressure as they travel within the tubes. The combination of gravity and pneumatic propulsion permits unusually high speeds at favorable costs in comparison with conventional rapid transit systems. Trains are supported and guided by wheels which ride on rails mounted within the tubes.

Five basic features of the GVT system are identified for modification in airport access and corridor service. Design speed of the vehicle (which is less than 200 mph in urban applications) would increase to 300 mph for airport access and 400 mph for the corridor system. Maximum tunnel depth between stations would vary between 2,000 and 3,500 feet respectively with tunnel slopes no greater than 12%. The long-stage GVT design would also necessitate the construction of crossports between two parallel tunnels to permit the circulation of "thin air" in front of a train back into its tube behind it. Special gate valves would have to be developed to prevent crossported air from decelerating trains moving in the parallel tubes. Some additional modifications in the basic vehicle design would also be necessary.

The report analyzes all aspects of the GVT system with reference to its applications in airport access and long-stage corridor service. These include propulsion; tunnels, tubes and stations; train configuration; operational features; and performance estimates based on computer simulation of a GVT prototype. Two proposed applications are discussed in detail -- access at Dulles Airport and service in the Northeast Corridor. Detailed performance projections are appended. The report also recommends further research and development projects with regard to design of the crossports and wheel-rail suspension dynamics.

NTIS Order #: PB-192-736
PC \$3.00, MF 95¢

Title: "Urban Gravity-Vacuum Transit System: Mark 4B and Mark 3B Baseline Definitions"

Author: Tube Transit Corporation (for Johns Hopkins University, Applied Physics Lab.)

Date: May, 1970

Project #: TRD-43

Keywords: 1. Tubes and Tube Vehicles 4. Speed and Speed Control
 2. Tunnels and Tunneling 5. Center City
 3. Pneumatics

Abstract: The purpose of this report is to describe the Gravity-Vacuum Transit System (GVT) of urban passenger transportation. The system employs a pair of steel tubes which dip between stations to depths as great as 900 feet into underground tunnels; the tubes are evacuated by electrically-powered pumps or compressors located near the stations. Cylindrical, pressure-tight trains, accelerated and decelerated by gravity and atmospheric air pressure, travel through the tubes; the trains are supported and guided by wheels that ride on rails inside the tubes.

The author defines two urban GVT systems that differ mainly in size. Primarily, this report discusses the details of construction and operation of the larger system, called Mark 4B Urban GVT; the Mark 4B configuration is considered to be best suited to large cities. The smaller system, Mark 3B Urban GVT, is considered better suited to the small city which does not require the larger capacity of the Mark 4B system; the smaller size of the Mark 3B configuration affords significant savings in capital and operating costs.

Conventional trains traveling at 200 mph require approximately 10,000 horsepower simply to overcome aerodynamic drag; at higher speeds, the drag increases in proportion to the square of the velocity. To avoid prohibitive power requirements at such speeds, a vehicle must avoid traveling through air at sea level density; nonetheless, the vehicle must be surrounded by normal air pressure when passengers enter and leave. To satisfy these two conditions, GVT trains will travel through evacuated tubes, but will emerge from the tubes at each station. As a Mark 4B train enters or leaves the tube, its 10,750 square-inch cross section generates an axial pneumatic force of 77 tons - a force which, utilized to assist gravity acceleration/deceleration by means of pneumatics, can be perceived by the passengers; to maintain comfortable levels for acceleration and deceleration, each Mark 4B GVT train will weigh no less than 350 tons:

The same pumps and valves that evacuate the tubes can furnish propulsive power to the entire system by means of selective control of the 77-ton thrust. Each pump, mounted close to the station, can enjoy the luxury of a fixed location, a conservative design, and unrestrained access for maintenance; the train, in turn, avoids the weight, bulk, safety hazards, and maintenance problems associated with an on-board power plant.

A cost estimate is presented for a system consisting of three lines that would traverse Manhattan Island; each line would provide peak passenger capacity of 50,000 per hour per direction for Manhattan's Central Business District. The total estimated cost of the 92.9-mile, 74-station system is \$2,044 million (about \$22 million per mile).

NTIS Order #: PB-192-730
PC \$3.00, MF 95¢

Title: "The Varo Monocab System, A Baseline Definition".

Author: Varo, Inc., Transportation Systems Division (for Johns Hopkins University)

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. People Movers, Varo-Monocab 4. Routes and Routing
2. Demand-Responsive Systems 5. Speed and Speed Control
3. Electronic Vehicle Guidance 6. Guideways

Abstract: The purpose of this report is to describe the basic Monocab system. This system employs a large number of small, closely-spaced, electrically-powered vehicles, suspended from a monorail (guideway) network. The guideway network is a series of closed loops (zones) interconnected by high-speed sections. The vehicles operate automatically to transport passengers and/or material along the shortest route between origin and destination, bypassing all zones and stations which are not included in this route.

The Monocab operates on demand: when a user pushes a "call" button, the closest empty vehicle responds. When not in use, the vehicles park at a vacant gate within a station. Therefore, except during peak traffic periods, a vehicle is likely to be parked at the stations when the user arrives. If a vehicle is not available, the call is transmitted to preceding stations until an empty vehicle is found which can answer the call. The Monocab guideway can assume almost any configuration desired by the customer. It can be routed between maximum activity centers, with one or more loops in each center, or the route can be a simple dual guideway with small turn-around sections at each end. The guideway can contain curves with a radius of 10 feet and slopes of up to 10%.

Passengers are provided with the comfort, velocity, and ride-characteristics of an automobile. In addition to comfortable seats, lighting, and air conditioning, the Monocab vehicle is equipped with air-cushion springs and torque-bars to limit the accelerations and sway even in the presence of high wind gusts. The system operates automatically at slow speeds around 10 foot radius curves. The vehicles would reach speeds of up to 34 miles per hour around larger curves (385 foot radius) and up to 68 miles per hour on longer radius curves and straight sections of the guideway.

A central computer installation is not required to control either the vehicles or the stations. Rather, every vehicle contains its own electronic-logic which selects its path between origin and destination, and controls vehicle acceleration, deceleration, velocity and turns in accordance with coded instructions (signals) permanently installed in the guideway. When a vehicle does not receive correct instructions from the guideway, or if it does not receive the proper signals from any leading vehicle, the vehicle automatically stops. The vehicles use photo-optic devices for "reading" instructions from the guideway, and for detecting the presence and velocity of other vehicles.

NTIS Order #: PB-192-728
PC \$3.00, MF 95¢

Title: "A Westinghouse Vehicle System for Major Activity Centers: A Baseline System Definition"

Author: Westinghouse Electric Corporation, Transportation Division

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. Airport, access
2. Guideways
3. People Movers, Transit Expwy.
4. Aerial Structures
5. Qualitative Analysis
6. Quantitative Analysis
7. Propulsion Systems, electric
8. Tunnels and Tunneling
9. Computers, programming

Abstract: This report describes the application of a Westinghouse transit system to a regional airport. The system consists of passenger and cargo trains running on an exclusive right-of-way connecting the many elements of the airport. The author states that for complete flexibility, the guideway network will be doubled to provide two-way movement and will run at-grade, aerially and in tunnels; guideway crossover and branching switches tie the network together.

Both passenger and cargo trains will be fully automatic and electrically powered with each vehicle supported by pneumatic rubber tired wheels. The passenger vehicles operating singly or coupled into trains will stop at each station on fixed routes to provide comfortable, fast, frequent, and efficient service; during off-peak periods, the system may be operated in an "on-call" manner. Each 20 foot long air conditioned passenger vehicle will comfortably seat 16 passengers with room for 16 standees; a door four feet wide will facilitate loading and unloading of passengers. A ride quality comparable to a fine automobile, the author forecasts, will be achieved with acceleration, up to a maximum speed of 30 mph, and deceleration rates statically controlled to provide the smoothest starts and stops available in automated transit vehicles. The passenger stations serving the double guideway network will be of the completely closed center platform type, with automatic elevator doors which will open simultaneously with those of the train, providing added flexibility and a totally controlled environment.

The passenger and cargo trains will be powered by a low voltage, 480V, single phase a.c. contact rail system. The cargo trains, powered tractors pulling up to five trailers, will operate over the same guideway as the passenger trains. The cargo trains will haul mail, freight, refuse and interline transfer baggage, and will have links provided to the U. S. Post Office, cargo city, and the refuse disposal area. Each tractor will be 20 feet long and will be able to accommodate up to eight authorized personnel if necessary; the trailers, also 20 feet long, will be able to carry the standard airplane containers, including a full sized 747 container, with provisions for mechanized handling and securing. The cargo stations, located adjacent to the baggage make-up areas with easy access to the ramp, will be reached by a short diversion in the guideway; the stations will be equipped with mechanized handling systems to interface with the cargo trailers.

In determining the various aspects of the transportation system, four computer programs were run to study the train performance, power system under short circuit conditions, power system voltage regulation/load flow for abnormal load conditions and operating cost. From the train performance program, having factored in all the parameters of the vehicles and guideway, scheduled speed, trip times, peak power energy consumption, and other vehicle and/or train performance, data were determined for each route. The short circuit and voltage regulation/load flow programs were tools in laying out and determining the size of the power distribution system. The author states that they help ensure that under normal and abnormal conditions, the system will operate satisfactorily.

NTIS Order #: PB-192-738
PC \$6.00, MF 95¢

Title; "Fast Transit Link Systems, Technical Reviews of Four Baseline Definitions"
Author: R. W. Blevins, ed. (Johns Hopkins University, Applied Physics Laboratory)
Date: June, 1970 Proj. #: TRD-43

Keywords: 1. People Mover, Aerial Transit System
2. People Mover, General Electric Aerial Transport
3. Tubes and Tube Vehicles
4. People Mover, Scherer Monobeam
5. Aerial Structures
6. Aerodynamics
7. Guideways
8. Structural Analysis
9. Suspension
10. Switches and Switching
11. Rail, systems planning and design
12. Tracks and Trackage

Abstract: The report assesses technical aspects of four Fast Transit Link (FTL) systems designed to provide rapid mass transportation in point-to-point or linehaul service. Each proposed system was analyzed in reference to its potential application in high-density urban corridors, and each design is characterized by fixed guideways, headways exceeding 75 seconds, scheduled operation, and speeds above 75 mph. The report does not attempt to compare the systems or to recommend their construction at any particular location. The four FTL systems under review include: (1) the Aerial Transit System; (2) the General Electric Aerial Transport System; (3) the Gravity-Vacuum Transit System (Mark 3B and 4B); and (4) the Scherer Monobeam Suspension Concept.

The Aerial Transit System (ATS) is designed primarily for FTL service and consists of light-weight vehicles supported from above by pneumatic-tired trucks travelling along a flexible steel guideway. The guideway is supported by cables suspended from towers at a nominal spacing of 1200 feet. The ATS technical baseline definition is examined with reference to vehicle dynamics, ride quality, aerodynamics, system operation, control and propulsion systems, and urban design and environmental aspects. The review suggests further testing to evaluate potential structural and vehicle oscillation hazards.

The General Electric Aerial Transport System employs an inverted "U" shaped guideway with pneumatic-tired trucks enclosed within the guideway beam. The review analyzes the system with reference to control and communication, vehicle dynamics and ride quality, and propulsion and power distribution. The authors recommend additional testing of the prototype, particularly to assess potential communication disruptions caused by electrical interference from the propulsion unit.

The Gravity-Vacuum Transit (GVT) system employs a combination of pneumatic pressure and gravity to propel trains enclosed within an evacuated tube at higher speeds than can be achieved by conventional FTL's. The GVT baseline concept is reviewed in detail with specific reference to control systems, suspension dynamics, wheel-rail interaction, rail alignment and maintenance, and operational requirements. The authors note potential problems with regard to tracking instability, valve operation, recovery of stalled trains, requisite precision of rail alignment, and passenger comfort. Substantial further testing is recommended.

The Scherer Monobeam is a suspension concept that permits transit vehicles to operate on both sides of a single-beam aerial structure for simultaneous travel in opposite directions. The Monobeam is analyzed more as a unique suspension concept than as a complete FTL system. Four technical aspects of the baseline definition are reviewed, including guideway structure, suspension, vehicle dynamics, and switching.

NTIS Order #: PB-192-758
PC \$3.00, MF 95¢

Title: "Parametric Analysis of Generic Urban Transit Systems"

Author: B.M. Ford, et. al. (Johns Hopkins University, Applied Physics Laboratory)

Date: December, 1969

Project No. TRD-43

Keywords: 1. People Movers
2. Personal Rapid Transit
3. Guideways
4. Rail, cost
5. Rail, systems planning and design
6. Dual-Mode Systems

Abstract: The report examines generic urban transit systems to determine: (1) relationships among operational parameters (eg. vehicle speed, headways, station and grid spacing, route demand, etc.) and their effects on system performance; and (2) costs associated with various system designs and service characteristics. Total trip time was selected as the quantitative measure of performance.

Five generic transit systems are considered in the analysis; all presuppose a grid or network of automated guideways placed extensively throughout an urban area. These include: (1) on-call [ie. demand-responsive] network systems which employ small-car vehicles to provide direct, point-to-point personal rapid transit; (2) simple scheduled network systems in which vehicles operate over regular, predetermined routes; (3) combined feeder network and express fast transit link systems in which the small-cars are used to transport persons to express stations located in high-volume corridors; (4) two-class service [ie. local and express] scheduled network systems; and (5) hybrid network systems which provide dual-mode [ie. demand-actuated and simple or two-class scheduled] service.

The analysis attempted to delineate optimal parameters with reference to station spacing, grid spacing, mean headways, line speeds, trip times, line capacity, vehicle characteristics, investment costs, and annual operating costs. The authors conclude that on-call systems are considerably more sensitive to demand and that guideway costs represent the major economic barrier to implementation.

NTIS Order #: PB-188-984
PC \$6.00, MF 95¢

Index No. 3-00-43.14

Title: "Acceleration and Comfort in Public Ground Transportation"
Author: J. W. Gebhard (Johns Hopkins University, Applied Physics Laboratory)
Date: February, 1970 Proj. #: TRD-43

Keywords: 1. Speed and Speed Control 4. Quality Control
2. Ridership 5. Rail, rolling stock
3. Wheels

Abstract: This report presents the findings of studies that have been conducted to determine the relationship between acceleration and passenger comfort and acceptance. Conventional transportation systems such as subway trains and buses are now designed to accelerate at about 3.0 mph/s (4 ft./s²). The performance data of electrically powered rapid transit cars purchased by municipal transit authorities in the last 10 years indicate a range of initial accelerations from 2.5 to 3.2 mph/s (0.11g to 0.14g). This performance will accelerate a vehicle to a speed of 30 mph in 10 seconds.

Crucial to the longitudinal acceleration level that can be accepted by passengers is the preparedness of the passenger at the onset of motion. When the traveler is seated and expectant, the smooth takeoff of a jet airliner is not at all uncomfortable, although at 0.5g some difficulty would be found in leaving the seat. Nevertheless, when the trains in the Paris Metro system were fitted with rubber-tired wheels and acceleration was increased, complaints forced a return to the previous standard of about 3.3 mph/s that had been used with steel wheels. Sudden jerks on starting or stopping are especially objectionable, since they can cause an unwary standee to lose his balance.

Longitudinal accelerations and decelerations judged comfortable and acceptable on the basis of existing data obtained by rider ratings were in the range of 0.11g to 0.15g, and lateral accelerations were in the range of 0.06g to 0.22g. However, existing data are inadequate for specifying acceleration limits for systems one may want to consider for the future. Since the acceleration values found are about 0.10g lower than those that are accepted by automobile users, it may be worthwhile to investigate methods for making higher accelerations acceptable to mass transportation passengers, especially since certain new systems are being proposed that require fast starts and stops and rapid transitions between the main line and station sidings.

NTIS Order #: PB-190-402
PC \$6.00, MF 95¢

Title: "Human Sensitivity to Whole-Body Vibration in Urban Transportation Systems: A Literature Review"

Author: R. M. Hanes (Johns Hopkins University, Applied Physics Laboratory)

Date: May, 1970

Proj. #: TRD-43

Keywords: 1. Vibration
2. Vehicle, Design
3. Ridership
4. Bibliographies
5. Quantitative Analysis

Abstract: The report summarizes the literature on human sensitivity to vehicular vibration. Its basic objective was to correlate available data and to synthesize valid vibration standards for comfort in urban mass transportation systems. A total of ninety reference sources were consulted, emphasizing subjective estimates of vibration severity and original experimental data over derived recommendations. The authors note that additional emphasis was placed on studies which related vibration levels to ridership comfort and acceptability, as opposed to vehicle performance or physiological effects.

One overall conclusion which emerged from the survey indicated that a majority of relevant data came from only a few sources whose results were frequently divergent. That is, no reliable guidelines for passenger comfort were yielded by the data; rather, several conflicting results were obtained which did not provide any satisfactory basis for choosing any one of the recommended comfort limits in preference to another.

The literature survey revealed two basic data sources: (1) those obtained on "shake tables" in the laboratory, and (2) those obtained in field testing. These data are treated separately in the report. In both cases, testing considered vertical, horizontal, and sinusoidal vibrations on standing and seated vehicle passengers. The authors attempted to discern empirical "thresholds" of perception, discomfort, and tolerance for the various types of vibration studied. In each case, the literature revealed data which proved either contradictory or non-correlative. The authors also note that widely divergent testing methods and procedures further impaired reliable correlation of the data. These same problems were demonstrated in data obtained by field testing.

Appended material includes a full bibliography of sources used, relevant details from selected reports, ride indices recommended by various investigators, and selected data and analysis of anatomical and physiological effects of vibration.

The authors conclude that sensitivity to vibration (both vertical and horizontal) varies with frequency, but that the literature contains so little agreement that no clearly defined narrow region of maximum sensitivity can be specified. Three additional conclusions drawn were: (1) that interaction does occur among frequencies and among axes of vibration, but that available data did not sufficiently permit specification of such effects; (2) that a single index could feasibly be devised to measure vibration sensitivity in actual vehicles; and (3) that test data are likely to vary substantially among individuals and when different research procedures are employed.

NTIS Order #: PB-192-257
PC \$3.00, MF 95¢

Title: "Collection and Distribution Systems - Technical Reviews of Six Baseline Definitions"

Authors: E. J. Hinman, et. al. (Johns Hopkins University, Applied Physics Laboratory)

Date: June, 1970

Proj. #: TRD-43

Keywords: 1. People Movers, Alden StaRRcar 6. Propulsion System, electric
2. People Movers, Dashaveyor 7. Guideways
3. People Movers, Transivator 8. Pneumatics
4. People Movers, Varo-Monocab 9. Communications
5. Propulsion System, linear induction 10. Air Cushion Vehicle

Abstract: This report contains individual technical evaluations of six proposed collection and distribution systems. These systems are: (1) Varo Monocab System, (2) Westinghouse Vehicle System, (3) Transportation Technology System, (4) Sky-Kar Transivator System, (5) Alden StaRRcar, and (6) Dashaveyor Transit System.

The Varo Monocab System is designed primarily to serve as a transportation system for a major activity center. It consists of small, closely spaced, electrically powered vehicles suspended from a guideway network and operating in a demand-activated mode. The monorail guideway is supported at 60-foot intervals by steel columns. Along the high-speed sections the guideway is attached to the columns by sections of steel cable that provide the guideway with a "spring suspension". The Westinghouse Vehicle System for major activity centers consists of 20 foot long pneumatic tired, automatic vehicles, operating singly or in trains over an exclusive right-of-way. This system has evolved from the Transit Expressway and differs from it primarily in the use of a smaller vehicle, in the raising of the guidebeam above the support surface, and in the method of automatic control. The Transportation Technology Distribution System is an innovative small-vehicle transportation concept that employs air cushion pads for support and suspension, linear induction motors (LIM's) for propulsion and braking, and central computer control of vehicle speed, headway, scheduling, and routing. Six and twelve passenger vehicles are operated in a multiple-loop system with a maximum speed of 60 mph and a minimum headway of 10 seconds. The Sky-Kar Transivator System is designed to serve primarily as a collection and distribution system for major activity centers. The system consists of small vehicles supported from above by pneumatic-tired trucks that travel along a steel I-beam guideway supported from pylons having a nominal spacing of 50 feet.

A set of recommendations were generated by this study. The authors recommended that during prototype testing of the Westinghouse Vehicle System, special consideration should be given to potential communications interference resulting from electrical noise generated by the propulsion and power collection equipment. The short headway operation proposed for the Sky-Kar Transivator imposes a severe constraint on the time available for switching. It is recommended, therefore, that on-board switching equipment be developed.

The linear induction motor concept employed by the Transportation Technology Distribution System, provides an attractive alternative to rotary motors for low-speed, small-vehicle transportation systems. At present, however, LIM design has not been optimized for urban transportation applications. Also LIM motor thrust controllers have yet to be demonstrated under the range of operational requirements typical of an urban application. Further development effort in these areas is recommended.

NTIS Order #: PB-192-759
PC \$3.00, MF 95¢

292

Index No. 3-00-43.17

Title: "Technical Evaluation of Advanced Urban Transportation Systems, Summary Report"
Author: R. A. Makofski, ed. (Johns Hopkins University, Applied Physics Laboratory)
Date: June, 1970 Proj. #: TRD-43

Keywords: 1. People Mover 6. Headways
2. Personal Rapid Transit 7. Guideways
3. Distribution Systems 8. Propulsion Systems, linear induction motor
4. Rail, systems planning and design 9. Communications
5. Rail, rolling stock 10. Switches and Switching
11. Tubes and Tube Vehicles

Abstract: The report summarizes baseline descriptions of ten proposed urban mass transportation systems, with an emphasis on common technical problems. The ten proposed systems include four fast transit links (Aerial Transit System, General Electric Aerial Transport System, Scherer Monobeam System, and Gravity-Vacuum Tube Transit) and six circulation and distribution systems (Alden Self-Transit, Dashaveyor, Sky-Kar, TTI System, Varo Monocab, and Westinghouse Vehicle System). Resumes of each design as prepared by their respective contractors are included as appended material.

The systems were evaluated according to several criteria, including: (1) system strategy and operations, (2) control, (3) communications, (4) propulsion and braking, (5) vehicle guideway dynamics, and (6) switching. The report contains detailed statistical data along with comparative tables and photographs of the various system prototypes.

Six general conclusions and recommendations were advanced by the research. First, the design of a reliable, economical control system was found to be the primary requirement for implementation of the systems employing short headways. Conventional block control was found to be practical, providing a capability for frequent measurement of vehicle location and velocity could be installed. More sophisticated system controls employing a central digital processor were not found to be sufficiently developed for implementation. Second, the report cites potential sources of electrical interference with communications between vehicles and the control center. Third, the report notes a convenience-capacity trade-off between scheduled and demand-activated service. The authors recommend development of hybrid controls to permit regular scheduling during hours of peak-demand and personalized, demand-responsive service during other periods.

Fourth, the report notes potential problems in terms of vehicle-guideway dynamics, particularly lateral and rotational forces which may detrimentally affect ride quality. The authors recommend that dynamic simulations be undertaken to measure performance of guideway and vehicle prototypes. Fifth, switching problems were noted with reference to the need for translating large guideway sections. This was found to be incompatible with short headways; the development of more reliable and fast-acting switching hardware was recommended. Finally, the report recommends additional engineering development of linear induction propulsion systems.

Overall, the report does not attempt to recommend implementation of any one proposed system over the others. It does, however, provide comparable data and general system analysis to determine areas in need of further research and testing.

NTIS Order #: PB-192-731
PC \$3.00, MF 95¢

Title; "Center City Transportation Project -- Descriptive Summary"

Author: Arthur D. Little, Inc., et. al.

Date: September, 1970

Proj. #: TRD-44

Keywords: 1. Center City 4. Government, Federal
2. Urban Development, planning 5. Government, urban
3. Financing Mass Transportation, sources 6. Government, intergovernmental relations

Abstract: The report is a general description of the Center City Transportation Project (CCTP), an in-depth study of five major metropolitan areas. The CCTP employed a multi-disciplinary approach to generate basic information about transportation requirements in the core cities of Atlanta, Dallas, Denver, Pittsburgh, and Seattle. The authors note that phenomena such as urban sprawl and suburban development are reflected in changing patterns of intra-urban mobility, with consequent problems for transit planning. Disparities among key variables in the major cities have yielded an irregular pattern of requirements to which a standardized, national approach cannot address itself. Simultaneously, functional and spatial relationships within the center cities change too rapidly for long-range transportation plans to have adequate near-term impact.

The CCTP was designed to establish priorities for near-term improvements and the eventual accommodation of new technologies. The authors focus particularly on the need for programs which emphasize the marketing of existing public transit systems. The CCTP therefore attempted to relate its efforts to specific cities.

The report concludes that institutional barriers represent the principal obstacles to improved center city mobility. The lack of planning coordination, the jurisdictional divisions among modes, and the lack of viable financing alternatives in urban governments are examples of these problems. In addition, the authors conclude that urban governments are hampered in their ability to raise their share of matching-grant requirements and that public transit systems are relegated to a low priority in the competition for scarce local revenues. The report recommends a general reexamination of Federal grants programs in order to facilitate participation by more localities.

The report describes and examines strategies for transit improvement in cities of different sizes. The authors note particularly that Federal programming should emphasize preventive measures in areas of moderate size where public transport systems are not yet facing the crises found in the largest cities. A partnership between public and private community leaders is also recommended as an important step in fashioning innovative projects to upgrade center city transportation.

The CCTP focused upon "highly visible, near-term action projects" rather than the delineation of a new planning process. Specific programs were developed in each city within these criteria. The projects included: (1) Operation Intercept [Atlanta], where city-bound commuters were diverted from freeways into peripheral parking areas; (2) a truck tunnel [Dallas] to facilitate multi-level goods distribution; (3) a demonstration of the commuter and shopper minibus loop system [Denver]; (4) minibus service between a Model Cities renewal area and the Pittsburgh central business district; and (5) a technical study of "people mover" applications for the City of Seattle. Each of these individual experiments is summarized in detail.

NTIS Order #: PB-198-610
PC \$3.00, MF 95¢

Title: "Center City Transportation Project: Summary Report"

Author: Arthur D. Little, Inc., et. al.

Date: September, 1970

Proj. #: TRD-44

Keywords:	1. Center City	5. Urban Development, planning
	2. Government, Federal	6. Dual-Mode Systems
	3. Government, urban	7. Private Transportation, automobile
	4. Financing Mass Transportation, sources	8. Parking, planning
		9. Headways

Abstract: The Urban Mass Transportation Administration (UMTA) undertook the Center City Transportation Project (CCTP) in March, 1969. The Project's primary objective--involving intensive efforts in five selected medium sized cities: Atlanta, Dallas, Denver, Pittsburgh, and Seattle--was to establish a productive working relationship between UMTA and its constituency, the nation's cities, for the purpose of: (1) assessing local capabilities to implement and fund transportation improvements; (2) making a preliminary estimate of the aggregated market for such improvements in order to stimulate private sector investments; and (3) formulating guidelines for more effective Federal leadership consistent with local needs and national priorities.

Project teams, working with local planners, systems operators, private investors, and elected officials, strove to help establish priorities within a meaningful time frame that would allow for both near-term improvements (to help keep the market for public transportation viable) and the eventual accommodation of new technologies. In the opinion of local decision-makers, this approach proved more responsive and served to underscore the need for greater coordination between long-range regional planning and the quick-action flexibility required by city administrations.

The authors recommended several strategies for immediate action for coping with present and widely perceived urban transportation needs. Center city transportation systems should be multi-modal, coordinate with existing and planned land uses, and relate closely to regional systems. Commuter travel by public transport should be encouraged within the broader context of multi-modal transportation systems. This requires a high quality of transit services to attract auto travelers in addition to mode-dependent patrons. They further recommend that an adequate lead time be instituted to operationalize new technologies. Consequently during the immediate future, it will be essential to rely on the innovative use of existing available technologies. The evolutionary planning approach builds incrementally toward longer-range goals in terms of specific plans for constructing and financing facilities, and marshalling patronage. The interception or diversion of automobiles on the approaches to the center city or at outlying line-haul express transit stations should be encouraged. An integrated strategy of peripheral parking and complementary transit service provides a short-term solution to improved center city mobility. This implies transit service improvements and the establishment of parking charges which compare favorably with those in downtown facilities. Convenient transfer locations and short headways can reduce the perceived travel time of the dual-mode trips. However, the intercept strategy should complement, not compete with, line-haul transit services.

NTIS Order #: PB-198-609
PC \$3.00, MF 95¢

Title: "Center City Transportation Project: Atlanta"

Author: Arthur D. Little, Inc., et. al.

Date: September, 1970

Project No. TRD-44

Keywords: 1. Bus, express
2. Bus, shuttle
3. Highway, types
4. Center City
5. Traffic, flow
6. Private Transportation, automobile
7. Parking, capacity and demand
8. Trip Generation
9. Bus, commuter
10. Advertising and Promotion

Abstract: This report describes the efforts of the Center City Transportation Project (CCTP) in Atlanta, Georgia. In Atlanta, the public transportation system provides an effective alternative to the automobile only when the latter is unavailable or inconvenient to use. Heavy reliance on the automobile, by itself, does not necessarily cause problems. The problems arise with the care and maintenance of the auto in the center city, a matter that requires the provision of more space than current land uses can afford.

Since World War II, Atlanta's main transportation improvement has been an expressway network supplemented by five arterial highways radiating out from the heart of the center city. In a radius of roughly three miles from the downtown section, these arterials must cross a belt of railroad lines that act as a traffic barrier in much the same way that a river does in other cities. At these cordon points, traffic flow is restricted. The expressways have high volumes of traffic, particularly on approaches to the center city.

An initial proposal for the Atlanta CCTP was the institution of shuttle bus service between downtown and underutilized parking lots at the stadium and Civic Center. The Atlanta Transit System (ATS) had the buses, and there were sufficient parking lots in the area. Thus the idea of "Operation Intercept" was developed. The ATS was willing to begin operating shuttle buses at once without any financial aid, provided that the City made its parking lots available.

Late in 1969, the "Town Flyer" shuttle bus began operations. During the month of December, the service operated for 14 hours daily through the downtown area. The service charge was only 50¢ for a parking space and round trip bus ride to and from downtown for each occupant of the parked car. The ATS provided buses, drivers, and parking lot attendants; the City furnished the parking lots at no cost, and downtown business interests helped with the initial promotional campaign.

The authors found that although the experimental phase of the service was hardly a financial success (The 50¢ fare covered only about 30% of the operating costs.), a large number of people seemed satisfied enough with the service to use it on a continuing basis. Origin and destination surveys confirmed this high latent demand, revealing that over one-half of the riders used the service more than occasionally. Downtown parking studies showed that there was an emerging parking problem, particularly in the core of the center city where there is already a shortage of long-term parking facilities. To compound this problem, currently planned new office construction will generate a parking demand conservatively estimated at 1,000 new spaces per year. These problems indicate a need for peripheral parking facilities in the near future.

NTIS Order #: PB-198-605
PC \$3.00, MF 95¢

Title: "Center City Transportation Project: Dallas"

Author: Arthur D. Little, Inc. et. al.

Date: September, 1970

Proj. #: TRD-44

Keywords:	1. Center City	4. Parking, facilities
	2. Traffic, congestion	5. Bus, busway
	3. Tunnels and Tunneling	6. Bus, stations and shelters

Abstract: This report covers Phase II of the Center City Transportation Project (CCTP) in Dallas. Within the study, three quick-action projects utilizing existing technology were developed and recommended for implementation.

A significant source of core area congestion in Dallas results from conflicts between trucks making deliveries and other traffic. The city lacks extensive alleyways and off-street loading docks; consequently 80 percent of all deliveries are made through the front doors of business establishments. If this pattern of curbside delivery is allowed to continue, by 1985 nearly all available curb space in the core area would have to be designated as loading zones. The CCTP team concentrated on implementing the first four sectors of an eventual system of nine truck-tunnel compartments, described in the 1969 Central Business District Master Plan. A tunnel under Austin and Main streets would serve 20 acres including Main Place. Thanks-Giving Square would be converted to a park. A truck tunnel built at the time of conversion would serve a 13-acre area. The City Hall-Convention Center Complex, would be served by a truck tunnel that also doubles as an automobile connector to the parking garages. A truck tunnel at Griffin Square has the option of later tying into the unused Santa Fe Railroad tunnel to link up with the Austin-Main tunnel. Estimated cost for these four tunnels is \$9 million.

The authors' second recommended project was the multi-purpose terminal complex project. The major objective of this project is to use the terminals as vehicles for area redevelopment, in addition to their functions of reducing vehicular traffic in the center city. The terminals are envisioned as combination parking garages and intermodal transfer points--providing facilities for automobile and bus transit, and designed for eventual accommodation of rapid rail and people mover systems. Visitors to the central business district will arrive by auto, park their cars, and proceed by bus or pedestrian walkway to their destinations.

The third proposed project for Dallas is to convert Main Street into a busway which would be used exclusively for buses. Early stages of analysis of the bus routes revealed that if presently routed buses on Elm, Commerce and Pacific Streets were moved to Main Street in addition to the buses already there, 294 buses in both directions would be using Main Street during the evening peak hour. The conversion of Main Street into a bus street would greatly improve bus operations. Eliminating the conflict of buses and automobiles would reduce delays to buses, reduce waiting times at intersections and along the curb lanes, and result in an overall speedup of travel times over the length of the bus street.

NTIS Order #: PB-198-607
PC \$3.00, MF 95¢

Title: "Center City Transportation Project: Denver"

Author: Arthur D. Little, Inc., et. al.

Date: September, 1970

Proj. #: TRD-44

Keywords:	1. Center City	5. Traffic, congestion
	2. Distribution Systems	6. Private Transportation, automobile
	3. Highway, types	7. Bus, minibus
	4. Parking, facilities	

Abstract: This report describes the activities of the Center City Transportation Project (CCTP) in Denver, Colorado. The CCTP was a two phased effort: Phase I consisted of an inventory of present conditions and problems while Phase II involved the initiation of both quick-action and longer-term planning and demonstration projects.

The major effort of the CCTP team was the study of terminal and distribution facilities in which the following elements were included: (1) land use, (2) employment, (3) cordon traffic counts, (4) parking inventory, (5) interviews with bus passengers, (6) home interviews in 997 metropolitan area households, and (7) four consumer panel discussions.

In Denver, the present freeways do not directly serve the central business district. The Valley Highway skirts it on the far side of the Platte River Valley, and access is limited by the small number of viaducts over the valley. The meeting of non-congruent street grids along West Colfax Avenue and Broadway creates difficult intersections and congestion. The public transit systems are increasing fares and curtailing services, while the population remains overwhelmingly automobile-oriented. Denver also suffers from a parking deficiency of 11,000 parking spaces in the central business district.

Several alternative approaches to the solution of Denver's transportation problems were analyzed. The transportation problems of central Denver seem to be most amenable to a combination of approaches. This combined approach has as its goal the creation of a viable downtown area, easily accessible from suburban areas. Two essential elements of such downtown circulation are: an automobile intercept strategy and an improved line-haul system bringing people downtown. The automobile intercept strategy is a combination of facilities and services which induce the city bound motorist to change to public transit at an appropriate distance from the central business district.

There are essentially two types of facilities involved: terminal facilities (such as parking garages with additional services, such as convenience shops) and distribution facilities, or transit systems that can be boarded right in the parking garages to provide frequent rapid service to central business district destinations.

The authors recommend: (1) the initiation of the central business district mini-loop service as an internal circulation system; (2) the concentration of the downtown sections of regional bus routes into two corridors on 16th and 17th Streets and on Stout and Champa Streets; (3) the expansion of the one-way viaduct couplets across the Platte River Valley by upgrading the quality and increasing the number and capacity of river crossings; and (4) the development and progressive upgrading of a regional bus system.

NTIS Order #: PB-198-608
PC \$3.00, MF 95¢

Title: "Center City Transportation: Pittsburgh"

Author: Arthur D. Little, Inc. et. al.

Date: September, 1970

Proj. #: TRD-44

Keywords:	1. Center City	5. Pedestrians
	2. Land Use	6. Sidewalks
	3. Urban Development, planning	7. People Movers
	4. Bus, feeder	

Abstract: This report describes the Center City Transportation Project's effort in Pittsburgh, Pennsylvania. The project provided a multi-disciplined approach to the problems of mobility in the heart of this metropolitan area. Center city Pittsburgh includes the Golden Triangle plus adjacent functionally related fringe areas to the north, east, and south. Since the nearby Hill District and Oakland are part of Pittsburgh's urban core, the study was selectively broadened to encompass the problems of these strategic areas lying east of the Golden Triangle.

In Pittsburgh rapid expansion of offices in the Golden Triangle in recent years has helped sustain high land values in the retail core area. However, the core area is poorly organized and physically unattractive. Major department stores are dispersed within the Triangle, with the walking distances between stores being excessively long. Streetcar, bus, and automobile circulation with the Triangle is difficult because of the narrow streets and obsolete street pattern. Because of this circulation problem, some of the best fringe sites potentially available for redevelopment are presently inaccessible to the core area by public transportation.

The authors developed a planning framework which envision an evolving series of projects over the next decade. These projects, which were developed in conjunction with local officials, were designed to improve center city transportation within the broad context of regional transportation improvements. The three-phased action program includes immediate-action projects, short-term developments, and longer-term planning. As immediate-action projects the authors have recommended: (1) the implementation of a Stadium-Arena shuttle bus; (2) Golden Triangle--Hill District--Oakland transportation improvements; and (3) center city street, transit, and pedestrian improvements.

The pedestrian distribution plan was developed as a long range project to complement the street and transit circulation plan, and to improve pedestrian access within the Golden Triangle and the between the Triangle and fringe locations. The pedestrian distribution system includes skywalks and selective people-mover technologies.

NTIS Order #: PB-198-604
PC \$3.00, MF 95¢

Title: "Center City Transportation Project: Seattle"

Author: Arthur D. Little, Inc. , et. al.

Date: September, 1970

Project No. TRD-44

Keywords: 1. Pedestrians 4. Surveys
2. Sidewalks 5. Trip Generation
3. Topography 6. Center City

Abstract: This report describes the efforts of the Center City Transportation Project (CCTP) in Seattle, Washington. In Seattle the level of downtown vehicle congestion is generally minimal during the morning and evening peak periods; however, within the center city, pedestrian circulation poses a major problem.

Specifically, the report notes that steep grades between the waterfront and downtown core areas inhibit pedestrian travel. Although north-south streets are relatively level, the east-west streets in the central business district have grades ranging up to 16 percent. The CCTP team conducted a pedestrian survey in which ferry passengers, persons parking at curb and off-street facilities, and people at building entrances were interviewed. This survey revealed general travel patterns in the Seattle center city with reference to origins, linkages, and trip purposes. The central area was found to attract nearly 100,000 persons each day by all transportation modes between the hours of 7:00 A.M. and 7:00 P.M. The modal split was as follows: 62% arrived by private automobile, 27% by bus, 4% by ferry, and 6% as pedestrians. Shopping trips accounted for approximately 31% of the total pedestrian trips; work trips were 24%, personal business trips were 17% and commercial business trips were 12%.

The authors recommend that an integrated series of pedestrianways be developed. Emphasis is placed on maximizing the number of key pedestrian corridors in relation to new development. The report also concludes that primary attention should be given to reserving pedestrian corridors through proposed development complexes and to extending these corridors through renewed areas. The pedestrianway configuration would consist of moving sidewalks located on the steepest grades between the waterfront and the central business district. The proposed facility is intended to: (1) alleviate the steep grade conditions, and (2) tie in with expanded peripheral parking facilities.

NTIS Order #: PB-198-606
PC \$3.00, MF 95¢

Title: "Center City Transportation Project -- Consumer Analysis Guideline"

Author: Arthur D. Little, Inc.

Date: September, 1970

Proj. #: TRD-44

Keywords: 1. Market Research
2. Public Relations
3. Community Response
4. Surveys
5. Ridership, attraction
6. Government, Federal
7. Government, urban
8. Management, training techniques
9. Management, planning and analysis

Abstract: The report examines market research techniques and their application to urban mass transportation. An underlying principle is that public transit services may be viewed as a consumer product, with consequent requirements for market analysis and promotion. The authors note that transit patronage may reflect the same kinds of individual decisions that characterize the purchase of standard consumer goods. Thus they emphasize the subjective aspects of transit ridership as revealed in a study of center city transportation in five major metropolitan areas: Atlanta, Dallas, Denver, Pittsburgh, and Seattle.

The basic elements of market research are discussed briefly with reference to methodology, analysis, and utility. Patronage forecasting techniques are also discussed as a specific application of marketing theory. The authors conclude that forecasts of consumer behavior should become integral factors in the transit planning process. In addition, the authors recommend increased community participation in general transportation decision-making. Other relevant subjects such as the development of marketing programs and use of service improvement experiments as a source of market data are discussed briefly.

The authors recommend particularly the development of a continuous planning and information program which would employ market research data. They suggest that use of static "master plans" has not proven successful, and that a dynamic planning process should be substituted. In this context, market research would provide a continuous data flow with which transit operators, government administrators, and related planning agencies could update and modify on-going programs and services.

Three specific recommendations are advanced with which the Urban Mass Transportation Administration can encourage market-oriented programming by local agencies. (1) Federally-assisted research and development efforts should emphasize a better understanding of the transit market and consumers. (2) The latter programs should include national market-testing techniques that can be applied in various cities to help develop and test understanding of consumer market behavior. (3) Management training and technical assistance in market-oriented research should be provided to local and regional transportation agencies.

Appended material documents the results of household surveys conducted in each of the five center city areas. These are presented as representative samples of market research. Each is concerned essentially with consumer responses to specific service improvements in an attempt to isolate salient consumer issues and practices. All relevant statistical material and analysis is included.

NTIS Order #: PB-198-601
PC \$3.00, MF 95¢

Title: "Center City Transportation Project -- Financing Public Transportation"

Author: Arthur D. Little, Inc.

Date: September, 1970

Proj. #: TRD-44

Keywords: 1. Center City
2. Government, Federal
3. Government, state
4. Government, urban
5. Financing Mass Transportation, sources
6. Government, taxation
7. Budgets and Budget Planning
8. Fare, cost determination
9. Public Relations
10. Bus, school bus

Abstract: The report summarizes financing alternatives for public transportation in the center cities. A brief examination of current patterns reveals a characteristic profile of declining center city transit ridership and rising costs which cannot be met through farebox revenues. The authors also note that public assistance programs have emphasized highways and aeronautics at the expense of mass transit modes. Consequently, transit operations are caught in a cycle of rising costs, fare hikes, and patronage declines. The report focuses on needs and trends in the transit industry as well as current financial sources and productivity. An overview of these problems concludes that the demands for public services will continue to outstrip the financial capabilities of transit sponsors in the foreseeable future. The role of school bus services within overall urban mass transportation is also discussed.

Five working hypotheses were generated with which to evaluate funding alternatives in five center cities: Atlanta, Dallas, Denver, Pittsburgh, and Seattle. These assumptions include: (1) State and local governments will continue to experience fiscal problems and spending-revenue gaps; (2) The image of transit as a "loser" industry, unless soon reversed, will produce a permanent alienation among voters and political institutions; (3) The optimal transit improvement program will emphasize incremental projects rather than major overhaul; (4) Community resources will be required to defray labor costs, while capital and service improvements must be funded by higher (ie. state and Federal) levels of government; and (5) Evidence of a substantial Federal transit financing device will enhance the potential for state and local governments to assemble supportive financing for transit improvements.

Several specific federal financing options are explored in detail. These include: (1) financing through the Federal appropriations process, (2) prefinancing schemes, (3) financing through a quasi-public Federal corporation, (4) augmentation and diversification of the Highway Trust Fund, and (5) special transportation revenue sharing. Specific advantages and disadvantages of each alternative are discussed in detail. Local financing options are discussed with reference to property taxation, sales tax, vehicle registration fees, downtown parking surcharges, local tax relief, road pricing, and benefit-assessment land-value capture strategies. In addition, the role of state government in financing mass transportation is examined, particularly as a catalyst for attracting support by other institutions.

The authors conclude that basic to any solution of the "cost/fare squeeze" is the abandonment of user charges to finance urban mass transportation. In addition, increased local and state funding is recommended to permit greater participation in existing Federal grant programs. The authors also recommend reassessment of the Federal role to embrace broader funding of capital investment and research, long-term budgetary allocations for transit improvement, and diversification of the Highway Trust Fund to support multi-modal transport developments. Operating deficits would, however, remain a state and/or local concern.

NTIS Order #: PB-198-599
PC \$3.00, MF 95¢

Title: "Center City Transportation Project -- Institutional Strategies for Urban Transportation"

Author: Real Estate Research Corporation

Date: September, 1970

Project No. TRD-44

Keywords:

1. Government, Federal	6. Center City
2. Government, state	7. Urban Development, planning
3. Government, urban	8. Budgets and Budget Planning
4. Government, intergovernmental relations	9. Land Use
5. Financing Mass Transportation, sources	10. Management, planning and analysis
	11. Intermodal Competition

Abstract: The report examines center city planning and administrative institutions in five major metropolitan areas: Pittsburgh, Denver, Dallas, Atlanta, and Seattle. The purpose of the report was to evaluate public transportation management and to synthesize institutional recommendations with which to better provide center city mass transportation. The authors note that none of the cities studied reflected either the institutional or financial capabilities needed to undertake major improvements in public transit. In addition, they conclude that application of innovative technology is essential to center city transportation, but that existing institutions cannot effectively plan or implement such needed programs.

The report examines institutional problems in detail with reference to: (1) the philosophy of current transportation planning; (2) land use, environment, and transportation; (3) planning, operation, and implementation; (4) the geographic scale and levels of government; (5) current sources of financing; and (6) relationships in a multi-modal urban system. The limitations realized in existing structures are discussed in relation to several specific center city proposals to demonstrate their inability to utilize innovative technology.

Several guidelines were developed for selecting and organizing institutional alternatives for center city transportation. These include: (1) The principle of subsidies for both operational and capital expenditures must be accepted. (2) Elected governments are more sensitive and responsive to citizen needs than functionally-specialized agencies, including those which are transportation-oriented. (3) Where an elected governmental institution does not exist at the geographic level appropriate for controlling urban transit improvements, the next most effective alternative is a public body which combines policy and planning functions and has direct budgetary influence. (4) The variety of factors among different cities precludes application of a standard, uniform strategy for institutional change. (5) A shift in some planning, implementation, and operational authority closer to the local level is warranted. (6) Policy coordination should be the major criterion in choosing between existing or newly created institutions. (7) It is desirable to provide systematic and unified control over all land transportation modes. (8) The adaptation of local institutions must be reflected in Federal organizations.

The authors then developed specific recommendations for institutional reform at all levels of government. Existing state, metropolitan, and local governments are examined generally and compared with several possible alternatives fashioned for each. The alternative policy-planning configurations represent various combinations of modal specificity, independence, and integration (eg. with land use planning). Recommendations for center city management are discussed with reference to five specific transportation functions: auto diversion, people and goods distribution, pedestrian circulation, and mobility for transit captives. The report concludes with additional institutional recommendations for the U.S. Department of Transportation and the Urban Mass Transportation Administration.

NTIS Order #: PB-198-602
PC \$3.00, MF 95¢

Index No. 3-00-44.11

303

Title: "Center City Transportation Project -- Joint Development"

Author: Real Estate Research Corporation

Date: September, 1970

Proj. #: TRD-44

Keywords:	1. Joint Development	6. Urban Development, planning
	2. Center City	7. Urban Development, renewal
	3. Government, Federal	8. Management, planning and analysis
	4. Government, state	9. Land Use
	5. Government, urban	10. Financing Mass Transportation, sources

Abstract: The report examines joint development approaches to urban transportation planning and management. The concept refers to multi-purpose land use developments which combine mobility and functional activity (eg. by integrating transit, housing, commercial activity, and parking at a single site). The analysis emphasizes financial advantages of joint development which derive from private investments in joint projects that would otherwise require totally public funding.

The authors note several existing barriers to the application of effective joint development concepts by urban transportation planners. These include: (1) reliance by local planners on external funding for urban transportation; (2) the lack of a Federal commitment to joint development as a means of reducing funding requirements for local transit improvements; (3) concentration on minimizing direct costs of construction and operation by local transit administrators; (4) the lack of sufficient analytical techniques to reveal the interaction between transportation and land usage; (5) functional separation of governmental authority between transportation and other aspects of urban development; (6) the lack of a clearly mandated local authority to sponsor joint development; (7) the lack of uniform regulation of transportation modes among different cities; and (8) the need for additional information about the potential role for joint development in overall urban planning processes.

Several specific examples are cited with reference to the basic objectives of joint development. These include: fiscal support of the central city, funding of transportation improvements, strengthening of general center city development patterns, maximizing center city land usage, and providing opportunities for urban residents and securing community support for expansive renewal programming.

Three basic joint development strategies are described in detail. Passive strategies do not solicit external support for transportation improvements. Private sector development strategies attempt to promote private financial investments in center city transportation facilities. Seed development strategies involve government initiatives to promote multi-purpose land use around a transportation center which it is hoped will attract substantial private activity in the transit impact area. A detailed guideline for strategy selection within the context of specific urban conditions is provided. Organization and management of the joint development process is also examined. The report concludes with general criteria for selecting and evaluating proposed joint development projects.

The authors advance several specific recommendations for Federal, state, and urban governments to better employ joint development strategies in their planning structures. These recommendations emphasize creation of special multi-purpose planning agencies and incentive funding through grants-in-aid.

NTIS Order #: PB-198-598
PC \$3.00, MF 95¢

Title; "Center City Transportation Project: Urban Design Guideline"

Authors: Skidmore, Owings & Merrill

Date: September, 1970

Proj. #: TRD-44

Keywords: 1. Urban Development, planning 6. Joint Development
2. Center City 7. Government, urban
3. Corridors 8. Government, Federal
4. Vehicle, design 9. Ridership
5. Surveys

Abstract: The purpose of this report is to develop urban design guidelines for Center City Transportation. Three levels of urban design were considered: (1) City Form, the physical organization of the city, including the pattern of city development and corridors used for transportation systems; (2) Transportation Architecture, defined as the physical appearance and qualities of open or closed public spaces or buildings which include transportation facilities; and (3) Human Factors, the design for pedestrian/rider comfort, social contact and the stimulation of the senses by light, noise, temperature and visibility. Five cities were used as case studies for the purpose of determining the Urban Guideline Design. They were: Denver, Colorado; Dallas, Texas; Atlanta, Georgia; Pittsburgh, Pennsylvania; and Seattle, Washington.

The urban design work program in each of the cities used as case studies included an evaluation of existing physical development including buildings, street rights-of-way, open spaces and walkways. A reconnaissance survey of the five cities was made in order to provide a data base from which to proceed. A major part of the survey included communication with the members of the communities at all levels, from the man-on-the-street to the mayor in order to determine their understanding of the transportation environment.

From their studies of the development and transportation trends of the center city, the authors believe several major implications for future policy are indicated. They recommend that the planning and design of new transportation corridors to and within the center city should include architectural analysis of development problems and opportunities of adjacent areas in order to maximize joint development. Vehicle design should be based on consumer attitudes and preferences. In considering rider experience and performance specifications, it should provide for an attractive vehicle interior, for changing views, and for the enjoyment, convenience and mobility of the passenger. Increased communications are needed at all levels of government in order to stimulate a two-way dialogue between national interests and local interests.

NTIS Order #: PB-198-600
PC \$3.00, MF 95¢

Title; "Center City Transportation Project: Urban Transportation Concepts"

Author: Wilbur Smith and Associates

Date: September, 1970

Proj. #: TRD-44

Keywords: 1. Urban Development, planning 5. Sidewalks
2. Government, Federal 6. Distribution Systems
3. Government, urban 7. Center City
4. Land Use

Abstract: This report details the guideline of urban transportation concepts that was designed to aid the Urban Mass Transportation Administration (UMTA) and the nation's cities in their center city transportation planning. It is based on extensive in-depth transportation analyses in five center cities--Atlanta, Dallas, Denver, Pittsburgh, and Seattle. The underlying goal of this transportation guideline is the safe and efficient movement of people and goods through an enhanced center city environment.

This guideline identifies and evaluates the various concepts which can help promote rational decision-making and resource utilization. The authors examine ways to more effectively coordinate transportation facilities with complementary land uses and thereby promote better urban development patterns. The guideline also suggests needed areas for Federal research and demonstration efforts, including possible ways that UMTA can stimulate urban transportation innovation.

The urban transportation concepts drawn up by the authors stipulate that: (1) Effective land-use planning is essential to improve the character of the center city, to encourage orderly and compact developments, and to preserve movement channels for line-haul and center city movement systems; (2) Multi-modal center city transport systems should coordinate with existing and planned land uses and relate directly to the regional systems; and (3) Pedestrianway developments and micro-systems can improve internal mobility and serve as distributors from line-haul transit facilities.

NTIS Order #: PB-198-603
PC \$3.00, MF 95¢

Title: "Intra-Airport Transportation Systems: An Examination of Technology and Evaluation Methodology"

Authors: P. G. Freck, et. al. (Institute for Defense Analysis)

Date: December, 1969

Proj. #: TRD-51

Keywords: 1. Airport, planning and operation
2. Distribution Systems
3. People Mover
4. Headways
5. Switches and Switching

Abstract: The purpose of this study is to determine the technological and analytic techniques that are relevant to the solutions of intra-airport transportation problems. It also examines the analytical techniques used in airport circulation system evaluations which would be applicable to other urban transportation problems.

The problems associated with the movement of people and baggage within an airport are ones of congestion, long waiting times, and long walking distances. These result from an increasingly heavy, but unevenly distributed, demand for air travel, and inadequate and sprawling facilities. There is general agreement among authorities in the field of commercial aviation that unless new and imaginative solutions to the problem are found, the situation will get worse.

Automated transportation systems can be grouped into three categories according to the complexity of the control system. In Category 1 are systems with headways of several times the minimum safe stopping distance. Automatic switches for these systems may be located in the guideway and require several seconds for one switching operation. The transportation demands of most airports can be met by Category 1 automated transportation systems with cars of medium capacity (20 passengers) operating in trains. Because the guidance and control technology is available now and has been demonstrated for the BART system, the only major new technological improvement required is the development of an automated switch. In Category 2 are systems which have headways of slightly greater than one safe stopping distance and which require a fast-acting switch located on-board the vehicle. For all practical purposes, the frequently proposed small car (approximately six passengers), demand-activated systems must operate as do Category 2 systems to meet airport requirements. Even then, they are able to meet only the intra-terminal movement requirement, although it is apparent that the option of operating in single units or in multiple car trains would greatly expand their capacity range. Although Category 3 systems have been proposed for airport applications, the technological and safety problems associated with them indicate that introduction of such advanced forms of transportation is years away.

The authors concluded that: (1) All fully automatic transportation systems being proposed for airport application require further research and development. (2) During this study, no significant problem was encountered which would severely limit the transferability of the technology and selected analytical techniques from transportation problems within airports to similar problems within other major activity centers. (3) Two types of programs appear reasonable: a low-risk operational demonstration of an automated system with headways of several times the minimum safe stopping distance, and a higher risk prototype testing of a system with headways of slightly greater than one.

NTIS Order #: AD-702-738
PC \$3.00, MF 95¢

Title: "Reserved Lanes for Buses: The Shirley Highway Experiment"

Author: Jean G. Taylor (Institute for Defense Analysis)

Date: June, 1970

Proj. #: TRD-51

Keywords:	1. Bus, busway	7. Private Transportation, automobile
	2. Bus, commuter	8. Private Transportation, car pools
	3. Bus, priorities	9. Private Transportation, driver
	4. Traffic, flow	10. Parking, regulations
	5. Traffic, peak-hour	11. Surveys
	6. Traffic, control	

Abstract: The report discusses experience with an exclusive bus lane on the Shirley Highway serving Washington, D. C. The author notes that such priority schemes as reserved lanes for commuter buses can assist in reducing traffic congestion on major metropolitan highways and increase productivity of the transit system overall. The report begins with a brief overview of exclusive bus lane proposals with reference to similar experiments conducted in other cities. The report also discusses automatic metering systems which control access to major thoroughfares and allow preferential entry of transit vehicles. Evolution of the Shirley Highway project, initial planning, implementation, and administration are examined in the introductory text.

The author then focuses on specific aspects of the demonstration, beginning with possible driver reaction to the exclusive busway. The report notes that initial motorist reaction has been slight, but that possible adverse reactions and countermeasures can be anticipated. Potential litigation against reserved busways is examined with reference to: (1) the use of public tax revenues to give priority to private transit carriers, or (2) the possibility that chartering of the reserved lanes exceeded the authority of the Virginia Commissioner of Highways. The author also anticipates various lobbying efforts to achieve political opposition to the reserved bus lanes. The report suggests several countermeasures and palliatives to reduce any potential driver reaction.

The author also recommends that substantial data collection efforts be undertaken to assess before-and-after effects of the busway experiment. Some recommended areas for surveying would cover traffic counts on the highway, measures of traffic volume in the adjacent area, measures of truck traffic, auto occupancy, travel time, and ridership characteristics. Data collection methods are also suggested.

One fundamental objective of the Shirley Highway experiment is to reduce the volume of commutation by private automobile in the Washington, D. C., area. To facilitate this goal, the author recommends that incentives be provided to increase automobile productivity combined with disincentives for overall automobile usage. The former would permit car-pools to utilize the exclusive busway; the latter would enforce strict regulation of downtown parking by increasing costs and reducing availability. The author also estimates capital and equipment requirements to satisfy projected demand for commuter bus service.

The report concludes that the Shirley Highway busway experiment provides a unique potential for assessing the impact of bus priority plans on urban communities.

NTIS Order #: AD-708-019
PC \$3.00, MF 95¢

Title: "A Preliminary Examination of Maxibuses"

Author: Howard Margolis (Institute for Defense Analysis)

Date: July, 1970

Proj. #: TRD-51

Keywords: 1. Bus, Design
2. Bus, Express
3. Bus, Cost
4. Fare, Collection
5. Vehicle, Design
6. Government, State

Abstract: The report summarizes the potential for application of "maxibuses" in urban mass transportation. The term is introduced as a generic type of large-bus vehicle which embraces both articulated (segmented) and double-decker designs. The analysis focuses on: (1) overall viability of the concept, and (2) a preferred design.

The author notes that maxibuses are generally considered to be more economical than conventional linehaul vehicles due to their increased passenger capacity. The report examines anticipated savings from the introduction of maxibuses into present urban transit operations, and particular applications to optimize cost factors. Specifically, the use of large buses in express service and in conventional linehaul on high-volume arteries are contrasted. The author concludes that the economies generated by maxibuses will not be related solely to their increased capacity, and that pending a detailed cost-benefit analysis, savings of not more than 10-15% are expected. System-wide operation of maxibuses would actually be prohibitive. The most promising near-term application of large bus vehicles was demonstrated to be in connection with commuter express operations.

The report also compares articulated and double-decker buses, concluding that the latter is preferable because of its greater economy due to increased capacity, especially in the recommended commuter express operations. The author suggests additional research to further clarify the relative advantages of each design. The report also evaluates reaction to maxibuses within the transit industry. While most past experience with articulated buses has been unfavorable (due to low ridership), the author notes that increased demand for express services may restore the attractiveness of large-capacity vehicles.

The report cites development of reasonably inexpensive and compact automatic fare collection (AFC) equipment for buses as an important aspect of maxibus applications. This would permit passengers to enter at both front and rear doors (a major advantage for articulated designs) and would increase driver productivity. The author recommends close coordination between AFC programs and future research and development of maxibuses.

Sources of maxibuses are also discussed, since there is presently no regular United States manufacturer. The report recommends that initial demonstrations of the maxibus concept use European equipment. Appended material contains: (1) a state-by-state listing of legal restrictions on motor vehicle length and weight which the author notes might preclude some maxibus operations, and (2) advertising and vehicle specifications of Neoplan (brand name) maxibuses which are produced in Germany and marketed in the United States.

NTIS Order #: AD-711-596
PC \$3.00, MF 95¢

Title: "Center City Transportation: Summary of the National Urban Coalition Seminar in Minneapolis, Minnesota -- May 4-5, 1970"

Author: Elizabeth Parker (Institute for Defense Analysis)

Date: May, 1970

Project No. TRD-51

Keywords: 1. Center City
2. Government, Federal
3. Government, intergovernmental relations
4. Government, urban
5. Access, planning and control
6. Bus, intracity
7. Bus, rapid transit
8. Distribution Systems
9. Financing Mass Transportation, sources

Abstract: The report summarizes proceedings of a National Urban Coalition seminar on center city transportation. The meetings held in May, 1970, focused particular attention upon transportation requirements in Class II cities, particularly Cleveland, Detroit, Houston, Kansas City, Los Angeles, Miami, Milwaukee, Minneapolis, and New Orleans. The purpose of the seminar was to explore center city transportation problems and the role of Federal programs to meet them.

Specific topics covered in the summary include: (1) Federal funding for mass transportation, (2) priority center city transportation projects, (3) Federal selection criteria, (4) the Operation Intercept project in Atlanta, and (5) the Nicollet Mall project in Minneapolis.

The report concludes that center city access was a major problem common to all the Class II participants. Most representatives felt that circulation and distribution systems should be planned along with direct access improvements. Nearly all the cities were concerned with improvements to existing bus transit systems, although some were in the process of exploring bus-rail alternatives. Several specific projects emphasized in the proceedings included fringe-parking/bus transit, exclusive bus rights-of-way, bus shelters, improved bus information systems, people movers and other distribution systems, and planning funds.

The need for improved communications among local and Federal government agencies is discussed. Some representatives also expressed concern that short-range demonstration projects and "shot gun" assistance to a large number of recipients may hamper long-range development and implementation of major new systems.

NTIS Order #: AD-708-021
PC \$3.00, MF 95¢

Title: "A Survey of Propulsion Systems for Low-Emission Urban Vehicles"

Author: W.E. Fraize and R.K. Lay (The Mitre Corporation)

Date: September, 1970

Proj. #: TRD-52

Keywords: 1. Fuel, Types
2. Air Pollution
3. Propulsion Systems, Electric
4. Propulsion Systems, Hybrid
5. Speed and Speed Control
6. Brakes and Braking
7. Hill Climbing
8. Flywheels
9. Wheels
10. Quantitative Analysis
11. Batteries and Cells

Abstract: The report is an overview of low and negligible emission urban vehicle technology. The report examines a wide variety of fuels and propulsion units with reference to relative pollutant emissions and consequent vehicle performance. Five system alternatives were identified and analyzed, including: mechanical drives, all-electric drives, electric drives with flywheel energy storage, series hybrid drives, and parallel hybrid drives.

Six aspects of component technology are explored in detail, including: (1) fuels, (2) heat engines, (3) electric power sources, (4) energy storage, (5) electric power converters, and (6) transmissions. Under each category, a comprehensive inventory of existing and experimental design alternatives is examined both for feasibility of application and for relative emission levels. The authors focus particularly upon such factors as state of development, cost, supply requirements, safety considerations, and integration with overall system characteristics. Component descriptions are supplemented by detailed statistical material and schematic illustrations.

For comparison purposes, the report also discusses general emission data. The authors emphasize recent testing to determine "acceptable" levels of pollution and to evaluate several generic propulsion concepts in terms of their emissions.

The report also considers external or ancillary effects on emissions caused by the dynamic vehicle. An analytical model was constructed and utilized to study forces acting on the vehicle, power required at the wheels, and regenerative braking. A parametric study evaluated the effect of seven factors on vehicle performance and emission control, including the effects of: cycle cruise speed, average acceleration, stops per mile, time per stop, gradients, regenerative braking, and vehicle weight and number of passengers. A separate section of dynamic analysis demonstrates the equations developed for the latter studies; derivation of the mathematics is also included.

The authors suggest their analytical model for use in a methodology for ultimately selecting a complete, integrated propulsion system for low-emission urban vehicles. Although the report does not identify any particular system as optimal, the five generic concepts were evaluated for performance advantages and disadvantages.

NTIS Order #: PB-200-144
PC \$3.00, MF 95¢

Title: "Transportation System Candidates for Urban Applications"

Author: A.L. Handman, et. al. (The Mitre Corporation)

Date: May 28, 1970

Proj. #: TRD-52

Keywords:	1. People Mover	7. Guides and Guidance
	2. Personal Rapid Transit	8. Headways
	3. Vehicle, design	9. Demand-Responsive Systems
	4. Rail, systems planning and design	10. Bi-Modal Systems
	5. Bus, design	11. Taxonomy
	6. Guideways	12. Distribution Systems

Abstract: The report develops a classification schema for proposed systems of urban mass transportation. The purpose of the report is to present in a concise format the description and status of transit concepts and to review candidates for future RD&D programs.

Three criteria were employed to classify each system according to its functional, operational, and developmental attributes. Three elements comprise the system function category, including: (1) line-haul systems [characterized by long-stage routes, capacities above 10,000 passengers/hour, and velocities of approximately 25 mph]; (2) circulation systems [characterized by short stages of under 2,000 feet, fewer than 10,000 passengers/hour capacity, and speeds of approximately 25 mph]; and (3) special purpose systems [designed for both people and goods movement between two fixed points with a capacity not exceeding 4,000 passengers/hour and speeds of less than 1.5 mph].

Three operating mode categories were identified, including: (1) transit mode [fixed route and station systems with rigid headways and regular schedules to all stations]; (2) demand mode [demand-responsive systems with variable headways and schedules to selected stations]; and (3) origin-destination mode [personalized rapid transit, similar in flexibility to the demand mode, but providing point-to-point transportation without intermediate stops].

Five stages of development comprise the third classification: (1) operational systems [immediate availability]; (2) prototype development systems [availability in approximately two years]; (3) model development systems [availability in from two to ten years]; (4) engineering feasibility systems [availability in at least ten years]; and (5) conceptual systems [availability is indeterminable].

A literature survey was conducted to generate a comprehensive inventory of candidate transit systems for future research and development. The report documents relevant information concerning 123 individual systems embracing all categories. Data where available is provided with reference to system innovations, sub-systems, vehicle specifications, support and suspension, propulsion, guideway configuration, control mechanism, manufacturer's description, development status, and reference material.

The report concludes with a brief discussion of technical and engineering state-of-the-art. The authors conclude that among the three functional categories, line-haul systems are the most highly developed, with eleven designs already operational. Circulation systems are limited primarily to the transit mode and may thus become little more than miniature rapid transit systems. Most special purpose systems are also limited to the transit mode, although continuing development of modified escalators or moving sidewalks shows promise. The authors conclude that an overall need to encourage development in the demand and origin-to-destination modes was evidenced. An annotated bibliography is appended.

NTIS Order #: PB-198-616
PC \$3.00, MF 95¢

Title: "A Systems Study of Soft Ground Tunneling"

Author: Fenix & Scisson, Inc. and Arthur D. Little, Inc.

Date: May, 1970

Proj. #: TRD-53

Keywords: 1. Tunnels and Tunneling
2. Benefit-Cost Analysis
3. Construction, Materials
4. Materials Handling
5. Hydraulics
6. Construction, Costs

Abstracts: The report summarizes an investigation of soft-ground tunneling operations to identify and assess the potential technical and economic feasibility of new tunneling system concepts. Quantitative estimates were made of costs and rate of advance of different candidate system concepts relative to an assumed set of tunneling conditions. The magnitude of R&D effort required to achieve cost reductions and performance improvements over the 1970-1985 time period was estimated.

The study concluded that the major restraints to reducing costs and increasing performance in soft-ground tunneling accrue from the lack of any effective method for handling bouldery ground and from the lack of a method for rapid installation of the permanent tunnel liner concurrently with the advance of the face. With a 15-year R&D effort of \$35 to \$70 million, the author concludes these problems could be substantially overcome. Such improvements would ultimately decrease tunneling costs by 40-65% and advance rates would improve between four and eightfold.

Cost differences among the more promising alternative system concepts were found to be small relative to the range of uncertainty associated with the cost forecasts. The most promising areas of new technology were judged to be the dredgehead for excavation; soil-water balance, air-on-face, synthetic resins, and cryogenic freezing for ground control; modular vehicle and hydraulic pipeline for materials handling; and shotcrete and fast setting poured-in-place concrete for tunnel wall support.

NTIS Order #: PB-194-769
PC \$6.00, MF 95¢

Title: "Advanced Control Technology in Urban Traffic Control Systems -- Volume I: System Description"

Author: Sperry Rand Corporation, Sperry Systems Management Division

Date: October, 1969 Proj. #: TRD-59

Keywords: 1. Traffic, control 6. Computer, applications
2. Traffic, analysis 7. Intersections and Crossings
3. Sensors 8. Signs and Signals
4. Vehicle, monitoring 9. Algorithms
5. Communications 10. Traffic, flow

Abstract: The report describes a proposed Urban Traffic Control System (UTCS) for demonstration in the Washington, D. C., central business district. The system combines advanced sensory, communications, and computer technology to improve the efficiency of automatic traffic control devices in heavily congested urban situations. Existing traffic signals employ conventional local-dial mechanisms which operate irrespectively of traffic conditions in the vicinity. The purpose of a UTCS is to monitor such traffic conditions and report them to a central computer which can, in turn, operate local traffic signals accordingly. The present report outlines technical aspects of the proposed UTCS with reference to all major components.

An initial requirement of the UTCS development was selection of traffic parameters which became basic data inputs to the system. Four specific variables are used in the algorithms which determine traffic signal timing. These include: (1) occupancy [ie. total time during which a vehicle detector at an intersection is activated]; (2) volume [ie. number of vehicles per street lane per unit of time]; (3) queue [ie. number of vehicles, both moving and stopped, in line before a traffic signal at the moment it turns green]; and (4) stops [ie. total number of vehicle stops per lane per signal cycle]. Three additional traffic parameters are used to measure system effectiveness and to control re-cycling of the signals when warranted by changes in observed traffic conditions. These include: delay of vehicles at the intersection, average vehicle speeds in miles per hour, and average time spent by vehicles crossing the intersection.

Basic UTCS hardware is described within four categories: (1) detectors, (2) communications, (3) computer system, and (4) displays and controls. Detectors monitor traffic conditions within the given parameters and may be located at-grade, beneath the roadway surface, or suspended above traffic lanes. For the Washington UTCS demonstration, a system of loop detectors was found to provide suitable performance within the requirements of local ordinances and engineering state-of-the-art. Communications system alternatives are described in detail, ranging from complex radio transmission to the selected frequency-division multiplexing technique using leased telephone lines. Criteria for selection of the computer hardware is also developed in detail.

The UTCS is designed to supplement existing local-dial signal controls which remain intact to provide a back-up for the computer-controlled system. Control of traffic signal timing sequences is provided by developing a library of area "control patterns" for each of several groups of intersections. The display and control system provides three modes of traffic controls any of which may be employed at the discretion of the system operator. Selection of the desired control pattern for any given time may therefore be determined by time of day, operator choice, or by automatic response to specific traffic conditions.

The report concludes with installation, operation, and maintenance plans for the UTCS demonstration.

NTIS Order #: PB-188-963
PC \$6.00, MF 95¢

Index No. 3-00-59.1

Title; "Advanced Control Technology in Urban Traffic Control Systems -- Volume
IA: Bus Priority System Description"

Author: Sperry Rand Corporation, Sperry Systems Management Division

Date: March, 1970 Proj. #: TRD-59

Keywords: 1. Bus, priorities 6. Signs and Signals
2. Communications 7. Computer, programming
3. Intersections and Crossings 8. Computer, applications
4. Traffic, control 9. Algorithms
5. Traffic, flow 10. Sensors

Abstract: The report describes development of a Bus Priority System (BPS) to operate in conjunction with the proposed demonstration of an Urban Traffic Control System (UTCS). The latter combines advanced sensory, communications, and computer technology to regulate conventional traffic signals at key urban intersections according to traffic conditions. A proposed UTCS configuration to be demonstrated in Washington, D. C., is described in other reports generated by TRD-59. The present report describes a BPS which would give urban transit vehicles special consideration at intersections outfitted with automatic traffic control signals.

The authors examine system design requirements for the bus priority in detail with reference to advantages, control strategy, development of a local control algorithm, effects on cross street traffic, hardware selection criteria, and measures of effectiveness. The proposed BPS would employ a short range radio transmitter located on each transit vehicle. Receivers would be located at selected intersections where conventional traffic controls would otherwise delay travel time. These receivers would be linked to the automatic UTCS which, when activated by an approaching bus, would override its normal control pattern and hold the traffic signal at "green" until the bus had passed. The system would therefore, in effect, exempt the properly-equipped transit buses from regular traffic controls and give them priority clearance at congested intersections.

System implementation procedures are discussed in detail with reference to component equipment, computer programming, and coordination of the BPS with UTCS algorithms. A separate section of the report details all technical and engineering aspects of equipment design and selection. The latter emphasizes an evaluation of near-field transmission techniques, computer requirements, and display and control hardware.

The report concludes with a detailed demonstration plan which covers selection of test intersections, participation by the local bus companies, preliminary data requirements for calibration of the algorithms, and baseline data for system evaluation. Three measures of effectiveness were identified to serve as evaluative criteria. These include: (1) intersection gain [ie. performance of traffic controls at a BPS intersection assuming it was decoupled from the larger network], (2) total signal delay along a bus route, and (3) total unplanned stops along a bus route. The initial demonstration of UTCS will cover 100 key intersections in downtown Washington, D. C. Of these, 39 will be outfitted to handle bus priorities.

NTIS Order #: PB-190-847
PC \$6.00, MF 95¢

Title; "Advanced Control Technology in Urban Traffic Control Systems -- Volume II:
UTCS/BPS Programming Specifications"

Author: Sperry Rand Corporation, Sperry Systems Management Division

Date: March, 1970

Proj. #: TRD-59

Keywords: 1. Traffic, control
2. Bus, priorities
3. Computer, programming

Abstract: The report outlines specifications for computer programming in an Urban Traffic Control System (UTCS) and in a Bus Priority System (BPS). Both systems combine advanced sensing, communications, and computer technology to control traffic signals at key intersections in an urban area. The UTCS employs magnetic loop detectors to determine traffic conditions and regulates the signals accordingly to expedite traffic flow. The BPS employs special radio sensors to detect approaching transit vehicles and is linked with the UTCS to allow buses to cross intersections without having to stop. A basic component of both systems is an advanced computer capability which processes sensory data and transmits cycling instructions to the traffic signal controls. Software for the computer system is therefore a fundamental element which receives special attention in the present report.

Twenty-five specific computer routines are outlined for the UTCS along with thirteen for the BPS. In addition, data storage requirements for both systems are delineated. These routines are divided into three priority levels according to function. Priority Level I routines embody those functions that are directly associated with the measurement of vehicular traffic. Priority Level II routines are primarily those associated with controller commands, error checking, and data evaluation. Priority Level III routines provide the display and operator interface functions as well as data evaluation functions for which time is not a critical factor. The report documents computer programming techniques for each separate routine.

NTIS Order #: PB-190-848
PC \$6.00; MF 95¢

Title; "Advanced Control Technology in Urban Traffic Control Systems -- Volume III:
UTCS/BPS Equipment Specifications"

Author: Sperry Rand Corporation, Sperry Systems Management Division

Date: March, 1970

Proj. #: TRD-59

Keywords: 1. Quality Control
2. Traffic, control
3. Bus, priorities
4. Construction, contracts
5. Computer, programming
6. Sensors
7. Communications

Abstract: The report specifies required characteristics of all equipment to be used in a demonstration of the Urban Traffic Control System (UTCS) and the Bus Priority System (BPS). Both systems combine advanced sensing, communications, and computer technology to control traffic signals at key intersections in an urban area. The UTCS monitors traffic conditions and regulates the signals accordingly. The BPS employs radio sensors to detect approaching transit vehicles and is linked with the UTCS to allow buses special priority in crossing intersections.

The report was prepared to serve as the basis of requests for price quotations from potential equipment suppliers. The specifications for each system component are referenced in statements of work which define all tasks to be performed by the supplier in meeting the terms of a procurement contract.

The specifications are listed separately for each basic component, broken down among four general categories: (1) special purpose equipment, (2) UTCS computer system, (3) BPS computer system, and (4) installation. Special purpose equipment as defined includes the loop vehicle detector, bus detector transmitter and receiver, UTCS controller and adapter unit, bus communications system, map display, and traffic control panel. Other categories are broken down among manufacturer-supplied hardware, software, and requirements for personnel training and support. Specifications cover such aspects as design (eg. physical dimensions), preparation for delivery, and prototype equipment required prior to contract bidding.

NTIS Order #: PB-190-849
PC \$6.00, MF 95¢

Title: "Airport Access in the Baltimore-Washington Region: Immediate-Action Improvement Program and Planning Guide"

Authors: Peat, Marwick, Mitchell & Co. and the Metropolitan Washington Council of Governments

Date: March, 1971 Proj. #: TRD-63

Keywords:	1. Airport, access	5. Computer, programming
	2. Airport, planning and operation	6. Surveys
	3. Traffic, flow	7. Demography
	4. Computer, applications	8. Ridership, volume
		9. Traffic, peak-hour

Abstract: The purpose of this report is to develop an airport access analysis and forecasting process for the Baltimore-Washington airports. This study is restricted to the 1969-1972 time period, and is implementation-oriented. Its primary concern is with immediate-action measures capable of implementation within a six to thirty-six month time horizon.

The research was conducted in two phases. The first phase consisted of data collection, network coding, and data processing. Information was gathered pertaining to socio-economic and demographic variables, transportation facility service characteristics, and airport travel patterns. A survey of existing transportation facilities was made to determine the extent of transportation service in the study area provided by the street and highway systems and by the different modes of transportation. Pertinent characteristics of the transportation system were developed either from network analysis or from field travel surveys. These characteristics included travel times, delays, and costs associated with the various modes of travel employed by the airport traveler. Population and employment data were developed for 1965, and forecast for 1970, and transmitted for use in the access demand forecasting work.

The objective of the second phase of the study was to develop an improvement program for airport access in the Baltimore-Washington region. General problem areas were defined and policy decisions made regarding the focus of detailed studies.

The authors found the following major deficiencies in current regional airport access public transportation services: poor accessibility to low-density residential areas, lack of travel time reliability during the morning and evening rush hours, and marginal economic feasibility of current operations.

The researchers recommend that increased service to low-density areas be provided by either extending reservation routes to transfer points where free parking and taxi services are available or by operation of group-riding service. Significant improvement is needed in the operation of the traffic circulation system at National Airport and is contingent upon the implementation of a one-way circulation plan. The recommended plan permits further improvement at National Airport on either a near-term or a major reconstruction basis. Also, conversion of the partial one-way flow pattern at Friendship Airport into a complete one-way pattern will facilitate travel and eliminate a major safety hazard.

NTIS Order #: PB-198-820
PC \$3.00, MF 95¢

Title: "Design of Tunnel Liners and Support Systems"

Author: D. U. Deere, et. al. (University of Illinois, Dept. of Civil Engineering)

Date: October, 1968

Proj. #: TRD-69

Keywords: 1. Tunnels and Tunnelling
2. Boring and Boring Machines
3. Construction, Materials
4. Computer, Applications
5. Environment and Environmental Control

Abstract: This report proposes new design methods, based on both theoretical and empirical considerations, to provide the basis for improved and more economical tunnel linings. The authors feel that needed improvements in tunnel lining design methods can only be achieved by an increased awareness of the mechanisms and modes of behavior of the system composed of the tunnel and the surrounding medium, and that this awareness can best be obtained by a study of the behavior of tunnels in the field.

The first part of the report considers fundamental concepts of tunnel behavior and the effects of the construction process on the time-dependent equilibrium conditions of the tunnel-medium system. Tunnel liners are studied under a variety of conditions, including deep and shallow tunnels in media from the softest soil to the most competent rock, and considering the influence of discontinuities, non-uniformities, and environmental factors of many kinds. The breadth of the study is intended to establish the basic concepts and criteria common to all tunnels, and to aid in separating and classifying situation-specific problems.

The report includes a critical summary of existing theories and methods of tunnel lining design, covering such topics as continuum approaches, hypothetical constant loads on liners, deformation-dependent loads, the use of computer analysis, arching concepts, rockload concepts, rear abutment load, tunnel liner stability, analyses for multiple tunnels, rock reinforcement methods, and design methods in common use.

The uses and misuses of current theories and methods are discussed, together with the ideal conditions for application; in some cases, the error resulting from applying given methods under non-ideal conditions is indicated.

A general classification system for geologic materials is presented. In this system a general relation is drawn between geologic materials, the problems and behavior of tunnels in those materials, and the general design approach (soil mechanics, rock mechanics or continuum mechanics) to be used. Classification systems for specific and general use are suggested.

In the second part of the report the behavior of individual lined and unlined tunnels is considered; field observations of deformations and stresses in specific tunnels are examined and evaluated. Recommendations are given for improved tunnel lining design procedures and construction techniques, based on a combination of theoretical considerations and empirical observations of tunnel behavior. In some cases the recommendations include innovations in tunnel construction techniques and materials.

NTIS Order #: PB-183-799
PC \$6.00, MF 95¢

Title: "Headway Sensing for Automatically Controlled and Guided Vehicles"

Author: Bendix Aerospace Systems Division

Date: September, 1970

Proj. #: TRD-73

Keywords:	1. Headways	5. Guides and Guidance
	2. Vehicle, Monitoring	6. Sensors
	3. Instrumentation	
	4. Computer, Application	

Abstract: The goal of the program was to assess the state-of-the-art in headway sensing equipment and recommend preliminary design and breadboard programs which would test, evaluate and demonstrate the technology applicable to single mode Automatically Controlled Guideway Vehicles (ACGV's). A survey was conducted of currently or potentially available methods of measuring short headways (less than 3 times the required stopping distance) to an immediately pre-lead vehicle. The report does not discuss headway control, switching, or merging.

The paper summarizes the history of headway sensing, and describes general operational requirements, wayside sensing equipment, and vehicle-mounted equipment that have been proposed, built, implemented, or tested in vehicle separation systems. The survey data were extracted from the technology of basic industries such as automation, aerospace, rail, communications and signalling, and NASA and the military. Patents, technical journals and periodicals were researched. New concepts were synthesized where existing technology is available but not applied. The authors specify digital computation and signal conditioning equipment to process and communicate the headway data, and estimate characteristics of the equipment.

The report summarizes the technical features, operation characteristics, and physical characteristics of vehicle-mounted and guideway-mounted headway measurement systems, which are potentially capable of controlling the separation between automatic vehicles operating on a guideway. The study also describes the systems' physical characteristics such as accuracy, size, reliability, and power. Functional flow diagrams and estimates of the systems' costs are presented along with engineering evaluations and development programs.

The survey stresses near term application of vehicle-borne microwave sensors, wayside presence detection, and sensing nets to measure range and range rate between vehicles. The 10-mile guideway, 100-vehicle design point system is the reference installation upon which the number of system components, system cost, and system reliability is based. Data on other indirect sensing and profile control headway systems are also included.

The report recommends further testing and evaluation of two solid-state radar sensors and one wayside headway sensing system relying on a sensing net of presence sensors.

NTIS Order #: PB-198-452
PC \$3.00, MF 95¢

Title: "Control Considerations for Short-Headway ACGV Systems"

Author: E. J. Hinman, et. al. (Johns Hopkins University, Applied Physics Lab.)

Date: October, 1971

Proj. #: TRD-73

Keywords:	1. Headways	5. Computer, applications
	2. Personal Rapid Transit	6. Guides and Guidance
	3. Guideways	7. Rail, systems planning and design
	4. Communications	8. Speed and Speed Control
		9. Rail, automatic control

Abstract: The report is an engineering evaluation of ten proposed command and control systems for automatically controlled and guided vehicles (ACGV's). Automated guideway transit systems have received considerable recent attention as a possible alternative to the private automobile. The ACGV concept which most closely approximates service attributes of the private mode is personal rapid transit (PRT). This system employs small vehicles moving over a broad, fine-grained network of guideways and stations in an urban area to provide individually-programmed, point-to-point transportation. To accommodate the large number of vehicles and extremely short headways (less than 30-seconds) necessary for PRT operations, however, a complex and sophisticated control system is necessary. The purpose of the report is to assess state-of-the-art technology for controlling a network of ACGV's.

The report evaluates ten proposed control systems with reference to the vehicle regulation function. This entails headway and velocity maintenance, merging of cars from a siding onto the main line, and collision avoidance. Two basic types of short-headway control systems are identified: those which employ modified conventional block controls and those which use innovative digital processing. The evaluation revealed that block controls are inadequate for maintaining short headways in an ACGV configuration. The authors therefore focus on information and data inputs necessary for a digital control system. Headway regulation requirements, vehicle controller dynamics, and merging problems are described in detail.

The report notes that although conventional block controls are inapplicable for short-headway operations, they possess desirable attributes of fail-safe reliability and proven experience in the field. The authors therefore explore possible modifications to the conventional system with reference to theoretical capacity, headway regulation, collision avoidance, and velocity computing circuitry. The report also contains a detailed analysis of communications and computer applications in an ACGV network. Candidate communications systems are reviewed and evaluated; various computer designs are discussed with reference to interface and software problems.

Four basic conclusions are advanced in the report: (1) A vehicle regulation scheme using relative vehicle spacing and velocity as the basic data inputs was judged effective. (2) A modified block control system was demonstrated to provide both fail-safe control and flexible performance to permit variable guideway capacity. (3) Automated control systems will require substantial and complex communications which suffer potential interference problems from vehicle and propulsion noise. Data transmission must compromise between high input requirements and a data flow capacity which is limited by the number of vehicles. (4) State-of-the-art computer technology was found insufficient to meet overall ACGV control requirements. The authors recommend extensive additional research and development of all component units.

NTIS Order #: PB-205-013
PC \$6.00, MF 95¢

Title: "Operating Strategies for Demand-Actuated A.C.G.V. Systems -- Volume I: Design and Simulation"

Author: W.J. Roesler, et. al. (Johns Hopkins University, Applied Physics Laboratory)

Date: August, 1971

Project No. TRD-73

Keywords: 1. Guides and Guidance
2. Demand-Responsive Systems
3. Personal Rapid Transit
4. Rail, automatic control
5. Headways
6. Computer, applications
7. Computer, programming
8. Algorithms
9. Management, operations and techniques

Abstract: The report examines operating strategies for demand-actuated ACGV (Automatically Controlled and Guided Vehicle) systems with reference to design and simulation. One generic ACGV system is termed "personal rapid transit" (PRT), an automated guideway mode which permits demand-responsive, point-to-point transit within an urban network. Because the PRT employs small vehicles moving rapidly at short headways, design of the automatic control system represents a primary technical objective. General control functions include three categories: (1) headway and velocity maintenance, (2) merging, and (3) overall vehicle management [ie. system operation]. The present report explores alternative strategies for PRT operation in the latter category. In addition, the authors attempted to provide basic information for estimating the real-time data collection, transmission, processing, and storage requirements for alternative strategies.

Operating strategies refer to the logic criteria whereby various routine decisions are made in the overall control system. In this report, three characteristic decisions were selected to aid the general evaluation of alternative control systems. These decisions include: (1) selection of a vehicle to answer a request for service [eg. assigning a vehicle from station storage, calling in a passing empty vehicle from the dynamic main line, or waiting for the next inbound vehicle to arrive]; (2) disposing of an empty vehicle at a station after its passengers have alighted [eg. placing the vehicle in storage, assigning the vehicle to another passenger, or dispatching the empty vehicle to another station]; and (3) selection of a route for the vehicle to follow once it has been dispatched to another station.

The basic method for classifying alternative control strategies is according to real-time data requirements which increase as a system becomes more complex. For evaluative purposes, the authors compare three general classes of strategies. Class I strategies impose minimal real-time data requirements and operate according to a fixed set of programmed rules. Class II strategies allow certain decisions to be made in real-time by the central manager, but do not feed instantaneous trajectory information into the computer. Class III strategies are the most complex and provide central control for most system operations.

The report describes the alternative systems in detail with reference to the three characteristic decisions noted above. Relevant computer requirements, algorithms, and programming instructions are also included. The authors conducted simulations in each class of strategies to develop a comprehensive data base for future evaluations; results of each operational test are provided. In addition, the report examines the single station queuing model and a single station simulation.

NTIS Order #: PB-206-416
PC \$6.75, MF 95¢

Title: "Heat-Assisted Tunnel Boring Machines"

Author: J. P. Carstens, et. al. (United Aircraft Research Laboratories)

Date: September, 1970

Proj. #: TRD-78

Keywords: 1. Boring and Boring Machines 3. Heat and Heating
 2. Tunnels and Tunneling 4. Construction, costs
 5. Environment and Environmental Control

Abstract: The report documents a study to determine: (1) the increase in tunneling machine performance in hard rock resulting from heat weakening of the rock in advance of the tunneling machine, (2) the increase in hourly cost incurred by the heating system, and (3) the net effect of the increased performance and the increased hourly cost on the cost of the finished tunnel.

Rock-cutting experiments were performed on Barre granite using a gas laser for rock heating and disc-type cutters of various diameters. Analytical work included the preparation of specific heat-assisted tunneler designs and their expected performance and economics. An alternative form of using heat for tunneling was also investigated in which slots were melted in the rock instead of merely heating it. The study concludes that the operation of tunneling machines incorporating lasers to provide the heat-weakening is technically feasible, but economically unattractive. Radiant heaters have insufficient power density to effectively heat the rock, and high-temperature jets create serious environmental problems. However, the test program indicated that a more effective way to assist mechanical cutters would be to use concentrated thermal energy to melt shallow slots in the rock between cutter paths.

NTIS Order #: PB-197-243
PC \$6.00, MF 95¢

Title: "Feasibility and Evaluation Study of Reserved Freeway Lanes for Buses and Car Pools"

Author: Alan M. Voorhees & Associates, Inc., et. al.

Date: January 31, 1971

Project No. TRD-81

Keywords: 1. Lane, reserved
2. Bus, priorities
3. Traffic, peak-hour
4. Traffic, congestion
5. Traffic, flow
6. Private Transportation, car pools
7. Benefit-Cost Analysis

Abstract: The report attempts to determine whether the reserved lane concept can accommodate more people on urban highways during peak periods and at the same time, reduce the amount of vehicular congestion that exists during rush-hours. Two major objectives of the research were to: (1) determine the feasibility of moving more people with fewer vehicles on a given freeway by reserving one or more lanes for the exclusive use of buses and car pools during normal weekday peak periods; and (2) implement a demonstration project and monitor the operation of reserved lanes to evaluate their effectiveness. The I-90 Shoreway in Cleveland was selected as the site for this study, since its characteristics are applicable to a large number of urban areas.

The operations analysis included: (1) specialized data collection, (2) freeway flow analysis, (3) evaluation of the effect of accidents and other lane-blocking incidents, (4) evaluation of lane selection criteria, (5) detailed volume/capacity analyses, and (6) analysis of distance required for lane-changing.

The user cost analysis is broken down into direct costs of vehicle operation, parking costs, user time costs, and bus fares. The approach used in the evaluation was to calculate differences in operating costs resulting from changes in travel behavior and changes in freeway operations brought about by implementation of the reserved lane concept. Other potential benefits to the community and freeway users are stressed.

The report also summarizes the development, calibration, and application of the mode choice model which was used to predict shifts in travel behavior resulting from the reserved lane demonstration. Three major elements were discussed in detail with reference to traffic regulation and enforcement; they include legislation, attitudes of the police and the courts, and other pertinent aspects of urban law enforcement.

The author notes that success of a demonstration of the reserved freeway lane concept in Cleveland is dependent on how well a public relations and information-education program is implemented. Such a program must identify target audiences, increase public awareness of the on-going demonstration, stimulate and sustain interest among key groups of highway users, motivate participation in the demonstration project, and generally encourage a favorable public response.

Conclusions and recommendations set forth in the report bring together in brief form the principal findings of each of the technical elements of the overall study. Specific recommendations for further study are outlined.

NTIS Order #: PB-198-648

PC \$3.00, MF 95¢

Title: "Description and Cost and Timescale Estimates for Elements of a Gravity-Vacuum Transit Demonstration" [Final Report]

Author: Syracuse University Research Corporation

Date: July, 1970

Proj. #: TRD-85

Keywords: 1. Tubes and Tube Vehicles 5. Communications
 2. Testing Facilities 6. Instrumentation
 3. Site Selection 7. Rail, automatic control
 4. Land Acquisition

Abstract: The report develops comprehensive time and cost estimates for a prototype demonstration of the Gravity-Vacuum Transit (GVT) system. This innovative mode of high speed transportation employs aerodynamic pressurized trains traveling in evacuated tubes which slope downwards to the midpoint between stations. The natural forces of gravity are employed for vehicle acceleration as it leaves a station; automatic valves are then closed and the tube behind the train is pressurized to permit the vacuum ahead to draw it up to the next station.

The proposed full-scale GVT demonstration will employ a single 1.8 to 2.0 mile stage at ground level. This configuration will permit simulated operation at speeds of up to 170 mph. Engineering tests at 250 mph will also be facilitated with moderate alterations to the vehicle. The report describes all major aspects and components of the demonstration along with estimates of necessary time and cost.

The analyses are divided among five general areas, including: (1) site selection and facilities, (2) communications subsystem, (3) instrumentation, (4) control subsystem, and (5) demonstrator facility operations. The selected demonstration site is located approximately 25 miles south of Syracuse, N. Y., in an area whose topography matches the ideal system profile. An estimated \$95,000 will be required for land acquisition. Building and facility specifications are also outlined in detail.

Instrumentation components will record a variety of data relating to vehicle performance, air pressure and temperature, wheel displacements, clearance, noise levels, valve positions, and ride quality. The authors outline all major instrumentation requirements for both on-board and station measurements. The total cost will be approximately \$105,000.

The control subsystem is particularly important to handle GVT requirements for precise valve and braking operations. The report describes all major components in detail, and estimates a total subsystem cost of \$24,000. Finally, the authors note several general operations considerations with reference to project management, scheduling, and manpower requirements.

NTIS Order #: PB-196-786
PC \$3.00, MF 95¢

Title: "GVT 170/250 MPH Demonstrator Cost and Timescale"

Author: L.K. Edwards and Bruce E. Skov (Tube Transit Corporation)

Date: August, 1970

Project No. TRD-85

Keywords: 1. Tubes and Tube Vehicles
2. Budgets and Budget Planning
3. Speed and Speed Control

Abstract: The purpose of this report was to estimate the costs and timescale associated with a demonstration of the urban Gravity-Vacuum Transit (GVT) system. The proposed configuration will permit testing of a passenger-carrying vehicle at 170 mph as well as engineering tests of a 250 mph vehicle.

The general purpose of the demonstrator is to simulate a single GVT stage without incurring the time and expense required to build a tunnel. The demonstrator would allow a train to pass from one station to the other with instruments and/or a limited number of passengers. The tracks and tube would be installed in a representative manner, and there would be representative valves at both ends. Only one of the two tubes would be equipped to carry a train; the other would be present to assure dynamic similarity to the operational installation. The demonstrator is designed to be a full-scale representation of the Mark 3B GVT system; the Mark 4B system has a similar configuration, but is approximately 16% larger.

The report also describes the site selected by Syracuse University Research Corporation on which the demonstrator will be located. The local topography will simulate an ideal system profile, and the authors note that the site is also superior to other candidates in terms of accessibility, power supply, cost, ease of land acquisition, likelihood of local opposition, and other important characteristics.

Total cost of the demonstrator and test program is estimated at \$26 million. Timescale for the proposed testing and evaluation will span some 25-27 months, assuming that certain preliminary work is also approved. The cost of the recommended engineering tests (in which vehicles traveling at up to 250 mph would be employed) would be an additional \$1,000,000.

NTIS Order #: PB-196-785
PC \$3.00, MF 95¢

Index No. 3-00-85.3

327

Title: "Study of Technical and Cost Questions Related to the Feasibility of the Gravity-Vacuum Transit System"

Author: Bruce E. Skov (Tube Transit Corporation)

Date: July 28, 1970

Proj. #: TRD-85

Keywords: 1. Tubes and Tube Vehicles 7. Heating
2. Maintenance, Costs 8. Hydraulics
3. Construction, Costs 9. Pressure and Pressure Measurement
4. Headways 10. Rail, Rolling Stock
5. Air Conditioning 11. Rights-of-Way
6. Underground Structures

Abstract: The report examines a variety of special questions concerning cost and operational problems which relate to the gravity-vacuum transit (GVT) concept. The report is primarily a response to and an updating of earlier reports by subcontractors of Tube Transit Corporation which identified areas of technical and economic concern.

The author begins with a detailed analysis of maintenance requirements for GVT rights-of-way and equipment. The effects of temperature extremes on the subsurface structures and ventilation facilities are emphasized along with summaries of cost computations for the various maintenance activities. Systems operations are examined with regard to the headways necessary for moving different passenger volumes. The report also discusses human factors in terms of ventilation, air conditioning, heating, and other factors which affect passenger comfort. The GVT poses special problems in this regard due to frequent acceleration and deceleration situations and the need for pressurized vehicles. Cost factors in the construction of stations, tunnels, and tubes are outlined briefly along with summaries of the subcontractors' cost estimates.

Technical analyses of system reliability focus of brakes, doors, and suspensions of the proposed GVT vehicles, all of which employ conventional hydraulic principles. In his system breakdown evaluation, the author notes particularly the need for reliability due to the lack of turn-around capabilities at midpoints of a GVT line. Thus, breakdown of one vehicle necessarily halts the movement of other trains in the tube behind it. The evaluation describes a method for "dynamic retrieval" of stalled trains midway between stations. Two additional technical analyses consider the effects of temperature and pressure gradients on track alignment, and track coupling and the effects of acceleration forces to be experienced by GVT passengers.

A final section deals with recommended procedures for retrieval of a fully-loaded GVT vehicle which has become immobilized between stations. Several alternatives to the "dynamic method" described above are outlined, including: (1) pressurizing the tube behind the train to increase vacuum pull in front, (2) reducing the maximum slope to 15%, and (3) reducing overall train weight.

Appended material includes a technical note from the Aerotherm Corporation outlining tube, tunnel, and station environments with regard to temperature, ventilation, and air conditioning requirements. Additional material covers the baseline profile of a Mark 4B/15 GVT design for which maximum slope would not exceed 15% and thereby facilitate retrieval as discussed above.

NTIS Order #: PB-196-844
PC \$3.00, MF 95¢

Title: "Communications Technology for Urban Improvement"

Author: National Academy of Engineering, Committee on Telecommunications

Date: June, 1971

Project No. TRD-86

Keywords: 1. Communication
2. Urban Development, planning
3. Information Aids
4. Medical Centers
5. Air Pollution
6. Vehicle, monitoring
7. Sensors
8. Crime and Crime Prevention
9. Emergency Vehicles and Services
10. Government, urban

Abstract: The report examines developments in communications technology for urban improvement. The current status of city communications systems is described with reference to telephone, videophone, telephone data networks, mobile radio, radio and television broadcasting, public broadcasting, broadband cable networks, and interactive home terminals. The authors synthesized four evolutionary communications networks which appeared to have special promise for application in future urban systems. These include: (1) telephone networks for the transmission of pictures, voice, and written materials between two points; (2) cable television networks connecting offices and homes with a central facility for transmitting public information; (3) a broadband communications network of two-way television channels which interconnect major public institutions and large commercial enterprises; and (4) a multi-purpose city sensing network for collecting weather, pollution, traffic, vehicle location, and power status data.

The purpose of the report was to recommend several pilot projects designed to explore the application of these evolutionary networks in a variety of urban systems. Some twenty such proposals are outlined with reference to objectives, project scope, implementation, administration, site selection, evaluation, cost, and relevant literature.

The recommended demonstration projects are broken down among eight basic categories. For improved citizen-government interaction, the authors recommend development of a model Community Information Center to provide a wide variety of information services. Recommended pilot studies in education include developments in two-way instructional television, community information retrieval, and cable television for distribution of computer-assisted instructional services. Proposed applications in the field of public health concern telemedical systems to connect major hospitals with satellite clinics and nursing home facilities. The development of reliable long-path sensing devices is encouraged to permit improved monitoring of air pollution and weather conditions.

Three proposed pilot studies in the field of urban transportation include: (1) design and operation of a fully automated user information system; (2) demonstration of an automobile-transit interchange station with facilities for automated parking, fare collection, pedestrian guidance, and information services; and (3) investigation of potential reductions in travel requirements through improved point-to-point communications.

Recommended projects for crime prevention and emergency services include implementation of 24-hour television surveillance systems, an instantaneous method for locating the origin of emergency calls, and development of a Municipal Command Center for controlling a wide variety of urban emergency service operations. Other general projects are discussed with reference to updating the technological specifications for cable TV franchises, evaluation of requirements for an automatic vehicle monitoring system, and development of a data bank on urban radio propagation. Two special recommendations encourage the participation of minority groups in communications and development of low-cost local television programming.

NTIS Order #: PB-200-317
PC \$3.00, MF 95¢

Index No. 3-00-86.1

Title: "Research Requirements Survey of the Rapid Rail Industry"

Author: Thomas J. McGean (MITRE Corporation)

Date: June, 1971

Proj. #: TRD-90

Keywords:	1. Rail, systems planning and design	7. Management, training techniques
	2. Rail, rolling stock	8. Safety
	3. Noise and Noise Control	9. Fire Prevention and Control
	4. Crime and Crime Prevention	10. Surveys
	5. Fare, collection	11. Testing Facilities
	6. Power Distribution	12. Tracks and Trackage

Abstract: The report attempts to identify topical areas for future research and development, with special reference to rapid rail transportation. A unique aspect of this study was that it emphasized areas which were found to be particularly salient among transit operators and industry officials. Data were obtained through survey questionnaires and direct interviews.

The survey instruments were designed to assess the comprehensiveness of research and development programs in attacking problems basic to rapid rail systems design, operation, and management. Ten specific subject areas were examined, including: (1) noise and noise control; (2) vandalism and security; (3) ride quality; (4) system reliability and maintenance requirements; (5) fare collection; (6) propulsion, braking, and power distribution; (7) information and training; (8) fire and safety precautions; (9) derailment problems; and (10) other problem areas. All rapid transit properties in the United States and Canada were contacted; a supplemental survey was conducted among industry suppliers and manufacturers. Data collection methodology and procedures are outlined in detail.

Several specific recommendations for future research projects were generated for each topic. These were scored to yield sixteen problem areas for which increased attention was deemed particularly desirable by industry officials. Significantly, the top five problem areas were all concerned with noise control, fare collection, and security from vandalism. In general, the survey results recommended that future Federally-assisted research and development programs give increased emphasis in these five areas: noise; reliability and maintenance; security; training; and fire prevention, safety, and derailment.

The report also lists characteristics of each property contacted in the survey with reference to power distribution, power requirements, vehicles in use, platform dimensions, maximum cars per train, maximum speed, trackage, station stop delay, and third rail characteristics. Questionnaire results are reproduced on a chart which notes the number of priority designations assigned to each of 95 specific research items in 16 separate categories. The report concludes with appended material covering survey instruments, actual replies received in the mail solicitation, and specific recommendations generated by each respondent.

NTIS Order #: PB-204-438
PC \$3.00, MF 95¢

Title: "Automatic Vehicle Monitoring Technology Review"

Author: S.H. Roth (The Mitre Corporation)

Date: August, 1971

Project No. TRD-90

Keywords: 1. Vehicle, monitoring
2. Communications
3. Sensors
4. Management, operations and techniques
5. Research Operations

Abstract: The report is a detailed review of industry proposals for Automatic Vehicle Monitoring (AVM) technology development which were prepared in response to a Request for Proposals (RFP) from the U.S. Department of Transportation. AVM systems provide an instantaneous picture of fleet-vehicle operations in an urban situation, and allow a two-way digital/voice communication capability between the vehicles and a central controller. The RFP was issued to assess the implications of competing technologies and to identify promising concepts for future evaluation. The author provides a brief discussion of previous AVM studies as well as specifications for an AVM System Model contained in the initial RFP.

A wide variety of alternate technologies were among the 30 responses submitted for review. These embraced eight generic system configurations, including: (1) Dead Reckoning [in which speed and heading information are integrated to obtain location as a function of time from a known starting point]; (2) Phase Trilateration [in which the vehicle emits an RF carrier frequency modulated by an audio tone which is measured at dispersed stations to yield vehicle location]; (3) LORAN [long-range navigation] techniques; (4) Proximity Systems [in which on-board receivers identify location as vehicles pass "signpost" transmitters]; (5) Inverted Proximity Systems [in which the vehicle transmits its location to dispersed "signpost" receivers]; (6) Pulse Trilateration; (7) Triangulation [which measures the bearing angles of RF propagation from a vehicle to fixed receiver sites]; and (8) a miscellaneous category primarily for non-automated systems.

All proposed AVM designs are described with reference to component state-of-the-art and their relative advantages and disadvantages.

The report concludes that overall technology development was insufficient to permit selection of an optimum AVM system. The author notes particularly that available data did not adequately quantify the cost trade-offs among various system designs. However, based upon the review of RFP responses, the report identified four technologies as sufficiently promising to warrant further evaluation. These include: (1) a LORAN C system; (2) a phase ranging system constrained to conventional mobile channel and utilizing multiple receiving sites; (3) a phase ranging system using a wide deviation signal and fewer receiving sites; and (4) an X-band proximity system.

NTIS Order #: PB-207-849
PC \$3.00, MF 95¢

Index No. 3-00-90.3

331

Title: "The Effect of Reduced Fare Plans for the Elderly on Transit System Routes"
Author: Edward K. Morlok, et. al. (Northwestern University, Transportation Center)
Date: March, 1971 Proj. #: TRD-97

Keywords: 1. Fares, reduction 6. Computer, programming
2. Fares, cost determination 7. Quantitative Analysis
3. Fares, collection 8. Routes and Routing
4. Elderly 9. Management, operations and techniques
5. Ridership, profiles

Abstract: The report examines reduced transit fare programs for the elderly and attempts to develop an evaluative model for studying their effects on: (1) gross farebox revenues, (2) quality of service to other transit users, (3) route planning to better satisfy altered traffic patterns, and (4) operating costs resulting from the revised service. Reduced fare plans within the context of this analysis generally provide special off-peak rates for elderly passengers in an attempt to redistribute daily ridership and encourage greater transit usage by this "captive" age group.

The report notes results of five reduced fare demonstrations undertaken in Chicago, Los Angeles, Detroit, Toledo, and New York City. These results, however, emphasized general ridership data, and did not yield a model for evaluating economic effects on overall transit operations. The authors synthesize an empirical equation for measuring revenue change as the sum of three effects -- revenue gains from new base period rides at reduced fares, revenue losses due to former base rides using reduced fares, and revenue losses due to peak rides shifting to base. The formula therefore compares contrasting results of reduced fare experiments in which the elderly ride more often but at lower cost and during periods of otherwise low demand.

The model for estimating effects of reduced fare programs is outlined and discussed with reference to general revenues, schedule changes, cost savings, break-even analysis, and related computations. The report also summarizes the types of informational inputs necessary for accurate quantitative analysis.

Several major conclusions are advanced in the report. The authors demonstrate that conventional methods (in which the amount of fare reduction is multiplied by total trips to determine revenue losses) are incorrect. Rather, they argue that changes in the fare structure may be accompanied by an overall increase in transit ridership which may mitigate gross losses. Further, where transit operations (eg. routing, equipment in service, manpower allocations, etc.) are revised to meet changes in demand by elderly passengers during off-peak hours, the cost of such operations may be substantially reduced.

Appended material outlines derivation of the model, demand for transit among elderly persons, break-even analysis, the estimated effect of automatic fare collection systems and informational aids on elderly ridership, an evaluation of proposed fare reduction programs, and an actual program for computer analysis with the model.

NTIS Order #: PB-204-058
PC \$3.00, MF 95¢

Title: "Pilot Specification for the Procurement of Multiple-Unit Railway Commuter Cars"

Author: Pullman Incorporated, Pullman-Standard Division

Date: January, 1972

Project No. TRD-111

Keywords: 1. Rail, rolling stock
2. Rail, automatic control
3. Rail, materials
4. Vehicle, design
5. Quality Control
6. Construction, contracts
7. Brakes and Braking
8. Safety
9. Suspensions
10. Maintenance
11. Propulsion Systems

Abstract: This report was prepared by Pullman-Standard at no cost to the Federal Government as a pilot specification for urban railway commuter cars. Contractural procedures and performance requirements are outlined for the procurement, construction, and utilization of the passenger-carrying vehicles. The authors note that all specifications were developed around state-of-the-art technology.

Because commuter cars may be used under a wide variety of service and operating conditions, the report does not represent a universal specification. The pilot specification relates to a typical sample car in order to illustrate the factors which must be considered in a performance specification.

The analysis is broken down among four general categories: (1) contractual procedures; (2) system control, performance requirements, and testing; (3) car specification and design parameters; and (4) supplementary requirements. The pilot specification includes comprehensive criteria for both construction and performance evaluation and selection.

NTIS Order #: PB-210-230
PC \$3.00, MF 95¢

Title: "Qualitative Aspects of Urban Personal Demand"

Author: ABT Associates, Inc.

Date: August, 1968

Proj. #: NSS-1

Keywords: 1. Qualitative Analysis
2. Center City
3. Distribution Systems
4. Vehicle, Design
5. Demand-Responsive Systems
6. Trip Generation

Abstract: This report deals with the effect of a wide range of qualitative factors on the choice of mode for urban transportation. The author expresses the theme of the study in three statements: (a) "The chief determinant of the perception of the quality of transportation is the extent to which available transportation services satisfy the travel desires of distinct urban populations." (b) "These travel desires are a function of the spatial relationship among residences and valued opportunities." (c) "The relevance of specific qualitative factors depends on the trip patterns that are generated and the extent to which there is transportation service to accomodate these."

A simple model of the city was adopted as the basis for analysis which assumed a specified gradient of density, moving from very high densities to very low densities. The analysis of qualitative factors was decomposed into trip patterns so that clusters of problems could be discovered once the basic elements in the patterns had been detailed. There are three distinct clusters of problems of considerable consequence: collection and distribution in low activity density areas, transportation for medium density areas, and Central Business District circulation.

A demand-responsive vehicle system, a rather large fleet of small vehicles capable of picking up individuals upon demand, is required to provide reliable service, with a minimum of waiting time, between widely dispersed routes that cannot be served efficiently by a fixed route structure. Vehicle operating costs could be expected to be low, but the service would still be costly because of the high labor input required since this is not a type of service likely to lend itself to automation in the foreseeable future.

Improvement should focus on conventional bus operations and schedule integration to serve the medium-to-low density pattern to provide for reverse commuting. Transfer operations should be structured in accordance with factors relating to pedestrian circulation, orientation, and comfort. The nature of the problem in the medium density area appears to be such that a number of operating changes rather than a single solution are warranted.

The major source of unreliability in bus operation, the delays encountered during passage through the CBD, is of such magnitude that quite radical innovations in operating policies need to be considered; the density of activities and the level of demand in the CBD are high enough that a full-scale distribution system for people and goods movement should be considered.

The author urges further investigation of the problem and encourages the design of a new generation of vehicles that incorporates acceptable noise and vibration levels; lighting suited to the type of trip for which they are to be used; temperature control and air circulation systems that will keep the vehicles comfortable and free of fumes; seating arrangements suited to the acceptable level of crowding and related factors; and transfer environments which would provide shelter from the elements, smooth pedestrian flows, cleanliness, personal safety, etc.

NTIS Order #: PB-179-745
PC \$6.00, MF 95¢

Index No. 3-NSS-1.1

335

Title: "Guidelines for New Systems of Urban Transportation - Volume II: A Collection of Papers"

Author: Barton-Aschman Associates, Inc.

Date: April, 1968

Project #: NSS-2

Keywords: 1. Land Use
2. Social Benefits and Costs
3. Ridership
4. Quality Control
5. Urban Development, planning
6. Environment and Environmental Control
7. Quantitative Analysis
8. Qualitative Analysis

Abstract: This report is one of three volumes produced by the study of land-use and transportation relationships as part of the "new systems" study. In this volume, 13 authors discuss the role of transportation in modern urban life. The term "role" is broadly defined to include functions to be served, problems to be solved, goals to be achieved, or criteria to be met; much attention is fixed on identifying social and economic needs, and on attempts to link them to programs for the improvement of transportation and other urban systems. The papers in this volume are divided into five general categories.

The first category deals with criteria for the planning of urban areas and urban transportation in particular from the standpoint of the behavioral scientist. The second category deals with the subject of human and social values, their role in the development of public policy, and the techniques and potentials for relating values and goals to public plans and programs; the subject, the author points out, is very closely related to those both preceding and following it, forming a "bridge" between studies of human needs and behavior and the development of strategies for meeting such needs. The third category describes a great number of specific environmental criteria or objectives for the design of transportation systems; the authors indicate that these criteria are behaviorally-oriented, derived from speculations about the requirements of people who use or who are affected by a transportation system.

The fourth category explores existing knowledge about necessary and desirable linkages between land-uses and between transportation systems and urban form, representing an initial effort to establish an improved basis for the location and design of transportation facilities and for the location of land-uses in relation to one another and to transportation. In addition, the fourth category traces the history of the impact of changing transportation technology on patterns and forms of urban development, and charts some possible future roles for the various modes of transportation. The fifth category deals with a wide range of important urban problems and with their relationship to programs and strategies for the improvement of transportation.

The author states that aside from a general description of the subject to be dealt with, the authors worked largely independently, each developing his chosen topic on the basis of his past or current experience and research. The author notes that many specific points are dealt with in this volume which offer guidance of immediate and important value and which point to areas requiring additional research and study.

NTIS Order #: PB-179-334
PC \$6.00, MF 95¢

Title: "Guidelines for New Systems of Urban Transportation -- Volume III:
Annotated Bibliography"

Author: Barton-Aschman Associates, Inc.

Date: May, 1968

Proj. #: NSS-2

Keywords: 1. Bibliographies
2. Urban Development, planning
3. Computer, applications

Abstract: The report is a comprehensive bibliography of source material dealing with new systems of urban transportation. More than 1,000 references are listed, including relevant books, articles, and other publications. The authors note particularly their application of innovative computer technology to facilitate retrieval of sources and updating of the inventory over time.

All references were listed alphabetically by author with complete bibliographic information appended. Each entry was then assigned a "reference number" corresponding to its numerical position on the list. The report notes that by computerizing this data, new printouts can be generated easily to incorporate additional sources as they become available.

A second section lists eleven topical categories for retrieval by subject. These include: (1) goals and values for urban development; (2) urban structure; (3) socioeconomic, technical and managerial trends affecting urban development; (4) problems affecting urban development; (5) urban travel patterns; (6) central business district travel patterns; (7) general transit systems; (8) trip-generation and land usage; (9) evaluative methods for transportation and land use planning; (10) organizational, administrative, and procedural techniques for transportation and land use planning; and (11) research proposals for future urban transportation and land use systems.

A third section presents a table in which bibliographic references are represented by number, and the subject categories by letter. Applicable subject categories are indicated for each reference by placing in appropriate columns the symbol MAJ where the reference is of major significance to the study, or MIN where the significance is of a lesser order. The user can therefore determine at a glance which sources give particular attention to specific topics relevant to urban planning and transportation.

NTIS Order #: PB-179-335
PC \$6.00, MF 95¢

Title: "A National Urban Transportation Test and Evaluation Center"

Author: E.S. Cheaney and J.T. Herridge (Battelle Memorial Institute)

Date: October, 1968

Project No. NSS-3

Keywords: 1. Testing Facilities
2. Government, Federal
3. Rail, systems planning and design

Abstract: The report examines a proposed national urban transportation test and evaluation center. The purpose of such a facility would be to provide the Federal Government with a permanent installation capable of analyzing the manifold technologies being developed in the field of urban mass transportation.

In order to assess the utility of a national testing facility, the authors examined seven generic subtechnologies with reference to forces favoring technical change and programs underway which will require test and evaluation. The seven categories included: (1) large guideway vehicles [LGV], (2) small guideway vehicles, (3) buses, (4) conventional automobiles, (5) small cars, (6) dual-mode vehicles, and (7) moving-way systems.

The authors also analyze various nontechnical considerations which affect the decision whether or not to recommend construction of the center. Specifically, they note the advantages of maintaining a permanent installation, the lack of alternative testing facilities, and relevant precedents.

The report concludes that except for vehicles in the large guideway mode, existing or planned testing facilities can adequately satisfy the function of a national test center. On the other hand, the authors conclude that a proving-ground type of facility incorporating a test track is needed to support further development, testing, and evaluation of conventional large guideway systems. In this context, the systems tested would involve wheeled vehicles propelled by rim thrust, as opposed to high-speed designs which can already be tested at existing facilities of the Federal Railroad Administration. Specific recommendations for implementation of the LGV testing center are outlined in detail.

Appended material includes an inventory of existing and proposed test facilities, plans for an installation to be operated by the Office of High Speed Ground Transportation, cost estimates for the LGV test track, economic incentives for urban mass transit innovation and testing, management and ownership precedents, and a selected bibliography.

NTIS Order #: PB-183-063
PC \$6.00, MF 95¢

Title: "Urban Goods-Movement Demand"

Author: Battelle Memorial Institute

Date: October, 1967

Proj. #: NSS-3

Keywords:	1. Freight Movement	5. Urban Development, planning
	2. Surveys	6. Environment and Environmental Control
	3. Trucks and Truck Lines	7. Computer, programming
	4. Computer, applications	8. Quality Control

Abstract: This report concerns a study of urban goods-movement demand; the study developed a methodology for conducting goods-movement studies as an integral part of the urban planning process. Four types of urban goods-movement studies are defined: regional, area, facility, and waste.

An important part of the research effort was the development of a comprehensive list of urban planning applications of goods-movement data so that types of goods-movement studies could be defined, and essential goods-movement information needs could be determined. Interviews were conducted with urban planners to identify the present planning applications made of goods-movement data. In addition, a list of comprehensive urban-planning goals was developed, and planning applications associated with goods-movement were designed to achieve these goals. By combining the two types of applications, a comprehensive list of planning applications related to goods-movement was developed from which essential information needs on goods-movement were determined and goods-movement studies defined. Several types of additional research needs related to the movement of goods in urban regions were identified as the result of discussions with urban planners, field tests, and data analyses which were conducted throughout the study. These research needs fell into three major groups: (1) determination of the impacts of technological innovations related to the movement of goods on the urban planning process; (2) improvements of data sources for measuring urban goods-movement demand; and (3) improvement of goods-movement forecasting models.

Field tests of the procedures and forms developed during the study were made to test their applicability in urban regions of various sizes and spatial patterns, and to measure the operations of the various modes of goods-transport. The results of the field tests were used to modify the forms and procedures to better reflect conditions as they generally exist in the field. Common carriers, private truck-fleet operators, local cartage companies, and governmental agencies were included in the field tests.

The first section of this report outlines the recommended methodology that should be used for developing needed urban goods-movement information. The second section identifies the urban planning applications of goods-movement data, defines the four types of goods-movement studies, and determines the essential goods-movement information needs. In the third section, techniques for collecting, processing, and analyzing goods-movement data are identified, evaluated, and recommended for use. The next section consists of forms and procedures that should be utilized to implement the data collection techniques. The fifth section is devoted exclusively to a discussion of waste movements in urban regions, including needed types of data and techniques for data collection and analysis. The sixth section is a discussion of the applications of goods-movement information in the urban-planning process. The final section of the report identifies additional research needs that should be considered, and actions that should be undertaken in the short and long-range future so urban planners can better understand the impact of urban goods-movement demand on urban development.

NTIS Order #: PB-178-277
PC \$6.00, MF 95¢

Title: "Monographs on Potential RD and D Projects - Study in New Systems of Urban Transportation"

Author: Battelle Memorial Institute

Date: January, 1968

Project #: NSS-3

Keywords: 1. Quality Control
2. Guideways
3. Management
4. Vehicle, design
5. Urban Development, planning
6. Quantitative Analysis
7. Government, Federal
8. Propulsion Systems

Abstract: This summary report presents the results of a research study conducted in the field of new systems for urban transportation. The objectives of the study were: (1) to identify a list of potential Research, Development, and Demonstration (RD&D) projects in the areas of systems developments, component developments, operational design methodology, and planning techniques; (2) to subject this inventory to an engineering and systems analysis and a screening evaluation; and (3) to prepare a set of monographs on those projects that were worthy of a discussion after the screening process was completed. An inventory of potential RD&D propositions was generated by considering a matrix of factors involved in urban transportation, and by conceiving RD&D efforts that might be worthwhile with respect to each factor; the inventory is reported in its final form in this summary report.

All the propositions were studied and screened to determine what line of action, if any, could be recommended for pursuit, with regard to each. The initial screening was coarse, with the criteria used being general (consistent with the unspecific nature of the propositions at that point). As the evaluation proceeded, both the criteria and the RD&D propositions became more specific, more detailed, and more complete. As a result of the series of evaluations, some propositions were recommended for inclusion in the RD&D program, while others were rejected. A third classification was created for propositions that may become desirable at a future time; propositions in this category are those whose merits are dependent on successful results of other RD&D propositions.

Monographs were prepared on 18 propositions; most of these apply to recommended RD&D projects, but some were also prepared for propositions in the other two categories. The preparation of a monograph, the author states, does not signify the "importance" of the proposition. To make the most effective use of its resources, the author prepared monographs only on those propositions where it was believed that subjects of seeming importance would not be included in the scopes of the other contractors participating in the New Systems Study Project, or where divergent opinions regarding the disposition of a particular proposition had developed. A set of evaluation criteria was developed that enabled the author to rank each recommended RD&D project in an order of priority as to the desirability of inclusion in the RD&D program; the method of evaluation is also discussed in this summary report.

Table I lists the title, time, and costs for propositions that the author recommends for action; these are ranked in order of priority. Following are brief discussions of each proposition; the discussions state (a) the need, (b) the program, (c) estimated cost, and (d) term and urgency of initiation.

NTIS Order #: PB-178-684
PC \$6.00, MF 95¢

Title: "Design of Urban Transportation for the User -- Monograph #1"

Author: George Rosinger, et. al. (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords:	1. Ridership, attraction	5. Quality Control
	2. Intermodal Competition	6. Vehicle, design
	3. Public Relations	7. Rail, systems planning and design
	4. Public Transportation, automobile	8. Bus, design

Abstract: The report examines the need for greater understanding of the "transit user" and recommends a comprehensive study program to provide data for analysis of this problem. Specifically, the report notes ten basic factors which make any mode of transportation appealing to consumers. These include: (1) trip time, (2) convenience and flexibility, (3) ambience, (4) familiarity (eg. information and planning required for use), (5) comfort, (6) social mixing (ie. racial and class), (7) safety and security, (8) prestige, (9) cost or fare, and (10) condition of equipment and facilities. The authors demonstrate that in general, public transit operations compare unfavorably with private automobiles under these criteria, and that this problem is due primarily to transportation planning which has ignored these user appeals. The report discusses briefly earlier ridership research which has tended only to quantify demographic characteristics and other studies which have not specified the kinds of service improvements necessary to attract passengers.

The objective of the report is to therefore synthesize "human-oriented" evaluative criteria for urban transit systems. Four basic research goals are identified, including: (1) assessment of user needs and appealing qualities of mass transit; (2) derivation of design and operational requirements; (3) validation of these requirements through demonstration projects; and (4) formulation of specific guidelines for systems design.

In developing an inventory of user needs, the authors recommend several considerations which embrace weighting of transit attributes, advantages of the private automobile, public attitudes toward transit modes, transit usage within the potential market, public perceptions of safety and security in transit modes, user preferences for fare collection systems, aesthetics in system design, possible legislative solutions (eg. providing priorities for transit vehicles on certain streets and highways), and promotional methods (eg. better informational aids, fare passes, etc.). The report gives particular attention to the need for psychological scaling methods as a means of evaluating system responsiveness to user needs. Specifically, the authors recommend that the proposed study develop relative indices to suggest which basic factors are most important to passengers. Other stages in the overall research program are discussed in detail.

The report concludes with a brief discussion of program administration which covers estimated time, cost, and personnel requirements.

NTIS Order #: PB-178-244
PC \$6.00, MF 95¢

Title: "The Development of a Course of Instruction in Urban Transportation Management -- Monograph #3"

Author: William D. Hitt (Battelle Memorial Institute)

Date: October, 1967 Proj. #: 3-NSS-3

Keywords: 1. Universities 3. Management, Planning and Analysis
2. Management, Training Techniques 4. Management, Operations and Techniques
5. Manpower and Personnel

Abstract: The report discusses the development of a specialized course of instruction in urban transportation management, beginning with an overview of the problem. The latter projects present management problems and manpower requirements into the future, and concludes that a uniform training program for urban transportation managers is a necessity.

Parameters for the course development project are outlined along with a technical discussion which established specific criteria for course content. A seven-step schedule for course development is then outlined including: (1) identification of training needs, (2) specification of course objectives, (3) construction of the training program, (4) development of an evaluation instrument, (5) evaluation of the training program, (6) revision of the program, and (7) formulation and implementation of recommended alterations. Examples of suggested course work and evaluation criteria are included.

The report concludes with a brief discussion of administrative requirements and associated costs.

NTIS Order #: PB-178-245
PC \$6.00, MF 95¢

Title: "Application of Improved Management Methods to the Urban Transportation Industry -- Monograph #4"

Author: Norman E. Lobdell (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Management, operations and techniques
2. Management, planning and analysis
3. Management, training techniques
4. Manpower and Personnel
5. Government, Federal

Abstract: The report examines the need for improved management methods in the urban transportation industry, and recommends a Federally funded RD&D program to implement a proposed solution. The author is concerned primarily with the application of innovative management techniques. Several problems which preclude such innovations are outlined briefly, including low growth rates within the industry, slim budgeting for overhead, and consequent limitations on management specialization. These factors combine to restrict the managers' attention to day-to-day operations, with insufficient opportunities to experiment with new administrative methods and techniques.

Three conventional approaches to the problem are analyzed briefly. The first, providing special short training courses for transit officials, is intended to improve management "sensitivity" to innovative practices. The report notes, however, that without specialists to propose such practices within particular companies, managers may remain unaware of possible improvements. The two remaining alternatives involve: (1) contracting with transportation consultants for the solution of specific problems, and (2) the direct hiring of management specialists.

The latter approaches are examined in depth. The report notes that although the consulting services can provide immediate solutions to straightforward technical problems, the need remains for improved overall managerial specialization if long-range innovations are to be implemented successfully. Thus the author suggests that the strategy of hiring specialized management staffs would provide a longer term, more company-oriented perspective in the solution of transit problems, and would enrich the capabilities of the industry management overall.

A principal drawback to the hiring approach, however, is the cost involved for a company to retain permanent managerial specialists. The author therefore recommends a program of Federal assistance to the transit industry with which to secure management personnel with an emphasis on the development of new methods. A three-phase project to demonstrate this proposal is outlined briefly, along with a rough estimate of time and cost factors associated with each stage.

NTIS Order #: PB-178-246
PC \$3.00, MF 95¢

Title: "Land Use Involving Transportation Rights-of-Way -- Monograph #5"

Author: Norman E. Lobdell (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Right-of-Way 3. Land Acquisition
2. Land Use 4. Urban Development, planning
5. Center City

Abstract: The report outlines certain problems associated with the potential use of the spacial volume subtended by urban transportation systems, and recommends guidelines for future study. Specifically, the report focuses on the relationship between land used for urban transportation and the development of adjacent property or air rights. The author notes that land assigned to transit functions is presently used inefficiently, so that operations are concentrated on a single plane with space above the rights-of-way remaining underdeveloped.

Five factors are identified which have increased significantly the need for a better understanding of land use involving transportation rights-of-way: (1) Projected growth of core-city trip generation will necessitate the location of areas available for new rights-of-way. (2) The latter requirements will be increased by future demands for more specialized transportation services. (3) The need for coordination between transportation and other construction will therefore increase in immediate and long-range urban planning. (4) Selections among alternative urban transit systems will have to be made with reference to the potential use of rights-of-way as well as technical performance. (5) The extent to which transportation land use affects both density and attractiveness of adjacent areas will have to be quantified.

Based upon the latter factors, the author advances five additional elements basic to a proposed study of rights-of-way development. These include: (1) transit system definition (ie. type of guideway employed, noise generated, safety, and costs); (2) legal constraints; (3) aesthetic design; (4) potential users of the rights-of-way; and (5) available financing for developing rights-of-way.

The author proposes to integrate these considerations in a comprehensive study of the problems and potentialities of using the volume subtended by urban transportation systems. The recommended study would provide both raw planning data as well as specifications for implementing selected concepts. The technical approach to such a project is discussed briefly along with time and cost estimates.

NTIS Order #: PB-178-247
PC \$3.00, MF 95¢

Title: "Operations Analysis of Augmented-Guideway Systems -- Monograph #6"

Author: Norman E. Lobdell (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Guideways
2. Highway, types

Abstract: The report examines augmented guideway systems and recommends a program of study to establish evaluative criteria for future applications. The system concept embraces all forms of guideways which somehow enhance the performance of transportation traveling on them. The variety of such systems yields a continuum extending from improved foot paths through freeways to more sophisticated designs. The objective of the present report is to recommend a study from which evaluative criteria for augmented guideway systems could be fashioned.

The report attempts to identify certain general guidelines for classifying the guideways according to functional, operational, and economic characteristics. Eight dimensions of system function factors are examined, including: (1) the improvement in average speed offered by augmented segments of a guideway network; (2) the proportion of a total guideway network which is augmented; (3) the units which move over the guideway (eg. people versus vehicles or independently controlled versus automated units); (4) the type of overall network into which augmented segments would be integrated; (5) access (ie. the number of points at which the system could be entered or exited and the number of alternative methods for reaching the guideway); (6) the market size which the system will serve; (7) system capacity and the relationship between demand volume and performance; and (8) economic aspects.

Operational considerations in classifying and evaluating augmented guideway systems refer to access, headways, safety, maintenance, and management factors. The author particularly emphasizes the need for methods by which system performance can be reliably estimated. Economic guidelines apply to the cost-benefit ratio for achieving specific functional objectives.

The proposed study of augmented guideway systems would cover four phases dealing with: (1) the description of present concepts, problems, and literature; (2) the identification of specific elements which require additional study; (3) the completion of research projects into those elements; and (4) evaluation and analysis. The report concludes with a brief statement of time and cost estimates.

NTIS Order #: PB-178-248
PC \$3.00, MF 95¢

Title: "Urban Streets and Their Environments -- Monograph #7"

Author: Norman E. Lobdell (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Highway, types
2. Highway, planning
3. Housing
4. Urban Development, planning
5. Traffic, analysis
6. Land Use

Abstract: The report examines urban streets as an organic system which manifests variable relationships with aspects of the overall urban environment. The author notes that while substantial research has reflected upon the interrelationships among other aspects of urban development, no such study has been undertaken to assess the "nature" of urban street networks as a separate topic.

The objective of the report is therefore to propose a study of urban streets, with reference to the relationships between the street network and different aspects of the surrounding environment. Four suggested variables for study include: (1) traffic, (2) city planning, (3) dwellings, and (4) commercial activities. In terms of traffic, the study would evaluate the effect of traffic flow on one segment as it affects movement through the entire network. In terms of city planning, the study would suggest the importance of designing streets as they control other developmental considerations and as they interact with one another. In terms of dwellings, the study would assess the effect of street networks on the activities and aesthetic qualities of the housing they serve. Finally, the study would examine the relationship between commercial activities and the street system with reference to customer access and goods movement.

The report concludes with a brief discussion of the study proposal along with time and cost estimates.

NTIS Order #: PB-178-249
PC \$3.00, MF 95¢

Title: "Grouped Road Vehicles -- Monograph #8"
Author: Norman E. Lobdell (Battelle Memorial Institute)
Date: October, 1967 Proj. #: NSS-3

Keywords: 1. Bus, Design
2. Bus, Cost
3. Vehicle, Design

Abstract: The report examines state-of-the-art in grouped road vehicles and attempts to synthesize a proposed program of RD&D to evaluate their applicability in urban mass transportation. The concept involves controlling a group of vehicles with a single driver; articulated buses or tandem trucks are conventional examples. The report notes that the grouped vehicle principle has long been standardized with regard to rail-guided transit systems, and therefore focuses attention on variations of the highway bus for grouped applications.

The author briefly discusses previous attempts to demonstrate grouped vehicles and the reasons why many of these have failed. The problems are shown to have occurred primarily because testing was not carried out within the context of an overall transit system. Economical equipment modifications failed to generate increased ridership appeal; appealing changes were made at such high costs that increased revenues from the passenger volume were offset. Furthermore, the report suggests that making successful use of grouped road vehicles may require more than mechanical effort alone, and may necessitate a whole restructuring of bus transit operations. The author therefore recommends a new program of research, development and demonstration to evaluate the combinations of hardware and operations under which grouped vehicles would be viable supplements to urban mass transportation.

Three basic issue areas were identified around which specific research projects would have to be developed. Operational issues concern location of the experiment, its projected role in the overall urban network, size of the ridership market, and the nature of intended service. With reference to these operational considerations, the author recommends initial applications of grouped vehicles to be on the linehaul portion of a single transportation corridor. The major operational problem anticipated in the report involves interaction of grouped buses with other vehicles on the streets. Hardware issues concern achieving maximum customer appeal at least cost. Of particular interest in this context is the extent to which existing coaches can be sufficiently modified inexpensively for demonstration. Marketing and demand issues are concerned primarily with ridership demand for grouped vehicles.

The report concludes with a brief description of the proposed RD&D program along with time and cost estimates.

NTIS Order #: PB-178-250
PC \$3.00, MF 95¢

Title: "Models of Urban Transportation -- Monograph #9"
Author: Norman E. Lobdell (Battelle Memorial Institute)
Date: October, 1967 Proj. #: NSS-3

Keywords: 1. Quantitative Analysis
2. Urban Development, planning
3. Social Benefits and Costs

Abstract: The report examines the need for better understanding of urban transportation systems and proposes a study to develop analytical models. The author notes that previous transportation studies have concentrated primarily upon system descriptions, and that this emphasis has distracted attention from the need for evaluative criteria with which to assess the relationship between transportation systems and the urban environment. Such models would also be applicable for determining the implications of transportation policy for overall urban development planning and for satisfying basic social objectives.

Three groups of study areas are recommended which embrace the physical system, behavioral factors, and economics. In terms of the physical system, the study would provide empirical methods for assessing traffic flow, required dimensions of the system, and effects of the system on adjacent land use. The study would also attempt to quantify the behavioral (social) effects of transportation systems, particularly with reference to the satisfaction of general needs and desires. Finally the study would assess economic factors of an urban transportation model in regard to moving shoppers in business districts, allocating the modal split, and other similar considerations. The overall objective of the study would be to establish a methodology for the understanding of transportation phenomena in an urban environment as they interact with certain aspects of that environment.

The report concludes with a brief discussion of the study proposal along with time and cost estimates.

NTIS Order #: PB-178-251
PC \$3.00, MF 95¢

Title: "A Program to Establish an Urban Transportation Information and Analysis Center -- Monograph #10"

Author: J. William Vigrass (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Public Relations
2. Information Aids

3. Bibliographies
4. Government, Federal

Abstract: The report examines the need for an Urban Transportation Information and Analysis Center (UTIAC), and proposes guidelines for its development. The author notes that no systematic compilation of research documents in the field of urban transportation has been undertaken which would centralize information useful to planners, government administrators, transit operators, and the like. The report discusses existing transportation centers, which have until now been located on university campuses and scattered Federal offices. The objective of the report is therefore to recommend a methodology by which a UTIAC would be established, and to define its functions and operations.

The proposed Center would serve four basic functions: (1) ordering, integrating, and indexing the findings and information generated by individual projects; (2) evaluating this mass of information to determine significant conclusions; (3) synthesizing priorities, guidelines for evaluating future RD&D proposals, and long-range program objectives; and (4) disseminating information obtained in a format that will be most useful to transportation operators and planners. The report outlines recommended operations and outputs in detail.

The UTIAC would initially make substantial use of projects sponsored by the American Society of Civil Engineers designed to identify principal sources of urban transportation information. Analysis of the material would be classified according to subjective indices, including: (1) mode of transportation; (2) type of geographic area (eg. sub-urban, central city, or central business district); (3) system operation versus equipment; and (4) demonstration experiment versus equipment or methods development. The UTIAC would provide analysis for all reports generated within the field, organize documents according to the above criteria, and retrieve information from the overall system to meet specific requests. Two general groups of personnel would be employed by the UTIAC -- information specialists and technical analysts. The tasks for each group in setting up the system and in its operation are delineated.

The report also examines a variety of potential analysis outputs designed to provide comprehensive information services for transportation planners and the public. The recommended outputs include state-of-the-art monographs, demonstration-research needs reports, technical assistance for Federal agencies in evaluating demonstration project proposals, an urban transportation inquiry service, regular publication of bulletins and trade journals, assistance in the design of local programs, and the executing of internal research programs. The Center would therefore provide information services which range from the dissemination of raw data and the publication of its own technical analyses to the provision of direct planning assistance.

The report concludes with a detailed work schedule and projected costs of the UTIAC.

NTIS Order #: PB-178-252
PC \$6.00, MF 95¢

Title: "A Program to Evaluate Advanced Technology for Buses -- Monograph #11"

Author: E. S. Cheany and C. W. Vigrass (Battelle Memorial Institute)

Date: October, 1967

Proj. #: NSS-3

Keywords: 1. Bus, cost
2. Bus, design
3. Vehicle, design
4. Propulsion Systems, hybrid
5. Suspension
6. Communications
7. Quality Control
8. Environment and Environmental Control

Abstract: The report examines the need for new hardware in the area of urban bus transportation, and recommends a comprehensive program of research, development and demonstration for innovative bus technology. The objectives of fashioning such new equipment would be to increase in-service reliability of the coaches and to make bus transportation more attractive to customers.

The report analyzes present technology in the transit industry, and concludes that the private market is too small to attract innovative competition between the only two remaining domestic manufacturers of buses. The author notes that while conventional designs have improved upon their predecessors, little continuing development has been undertaken. In addition, the author notes that existing coaches present physical travel barriers to elderly and handicapped passengers, and that the incidence of road failures inflicts prohibitive time costs on riders. Two other problem areas identified in the report include operating (particularly labor) costs and the "riding environment" (eg. noise levels, lighting, and comfort).

The proposed remedy for these problems is through comprehensive re-design of buses to incorporate innovative technology. The author notes that the trend of ridership decline (particularly where former transit passengers have turned to using private automobiles) can only be offset by changing the "nature" of buses, rather than by piecemeal modifications of the existing design. The report cites patterns of similarly revolutionary technological advance in other industries, along with precedents which anticipate passenger acceptance of new hardware (eg. in the passenger railroads).

The report recommends a large-scale program of research, development, and demonstration to fashion new bus technology within specified gross design parameters for cost, size, duty cycle, and such operational requirements as acceleration performance, hill climbing capability, and low noise and exhaust emissions. Twenty-six possible improvements are listed with reference to passengers, bus operators, and the driving public. In addition, the report examines a number of specific technical possibilities for investigation under each of seven functional categories: (1) energy propulsion systems, (2) steering and suspension, (3) body structure (frame) and hardware, (4) controls and communications, (5) environmental control, (6) passenger accommodations, and (7) information systems.

A five-phase, \$4 million RD&D program for implementation of new bus technology is outlined.

NTIS Order #: PB-178-253
PC \$6.00, MF 95¢

Title: "Flywheel Energy-Storage Systems for Transit Buses" (Monograph #12)

Author: J. P. Wilcox (Battelle Memorial Institute)

Date: October, 1967

Proj. #: 3-NSS-3

Keywords: 1. Flywheels
2. Kinetic Energy
3. Propulsion Systems, Hybrid
4. Brakes and Braking, Regenerative
5. Speed and Speed Control
6. Air Pollution
7. Noise and Noise Control
8. Propulsion Systems, Internal Combustion
9. Batteries and Cells
10. Propulsion Systems, Horsepower
11. Hill Climbing

Abstract: The report briefly outlines the concept of and a proposed RD&D program for a flywheel energy-storage system of propulsion for individually-powered vehicles. The author is concerned primarily with the dissipation of a moving vehicle's kinetic energy as heat during braking, and he proposes development of an energy-storage device to be coupled with regenerative braking systems already available. The particular flywheel energy-storage system discussed in the report is compared with such alternative storage methods as batteries.

The principal advantages of the flywheel system are discussed, including: (1) reduced horsepower requirements during such transient demand-periods as acceleration; (2) recovery and storage of otherwise dissipated kinetic energy during braking; (3) reduced air pollution from exhaust for which emissions are normally greatest during acceleration; (4) quieter operation of the propulsion unit; and (5) improved vehicle performance during transient stress situations such as hill-climbing. The author relates these advantages to the operation of transit buses, noting their typically slow speed, stop-and-go, and engine-power requirements based on acceleration performance.

The report summarizes a proposed RD&D program for testing a flywheel energy-storage system and gives particular attention to potential disadvantages in the system which should be solved. A three-phase plan including projected costs is introduced consisting of: (1) a feasibility study of various hardware alternatives, (2) an engineering design of a prototype bus, and (3) construction and testing of the vehicle. The author concludes, however, that reluctance of both bus manufacturers and operators to explore the potential of flywheel energy-storage will necessitate public support of such an RD&D project.

NTIS Order #: PB-178-254
PC \$3.00, MF 95¢

Title: "The Development and Demonstration of a Family of Practical Moving-Way Transport Systems for Pedestrians -- Monograph #13"

Author: R. D. Leis (Battelle Memorial Institute)

Date: October, 1967 Proj. #: 3-NSS-3

Keywords: 1. Conveyors 4. Distribution Systems
2. People Mover, Carveyor 5. Pedestrians
3. People Mover, Transivator 6. Switches and Switching
7. Access, Planning and Control

Abstract: The report assesses the technological development of moving-way transport systems for pedestrians in urban areas. Although the author notes a substantial volume of literature in the field, he concludes that such conveyor-type distribution systems have not been sufficiently demonstrated and recommends a detailed RD&D program.

The largest barrier to effective application of moving-way transport systems is the variety of factors that affect the basic configuration and components of the hardware in urban areas. The author cites a need for development of a family of moving-way systems to demonstrate the adaptability of particular configurations where particular requirements exist. A vital preliminary step in this procedure would be identification of uniform requirement-situations applicable in different cities.

Specific system concepts are discussed in some detail along with such basic performance criteria as speed, safety, durability, cost and capacity. Specific system developments including the Transveyor and Carveyor are described as well as such generic designs as switched systems, continuous integrated transport, and intermittent-entry systems.

The author concludes with a discussion of future research to be undertaken, a recommended research procedure, and an analysis of program schedule and costs.

NTIS Order #: PB-178-255
PC \$3.00, MF 95¢

Title: "An Investigation of Steel Wheel-Rail Noise and Techniques For Its Suppression -- Monograph #15"

Author: J. J. Enright (Battelle Memorial Institute)

Date: October, 1967

Proj. #: 3-NSS-3

Keywords: 1. Noise and Noise Control 6. Interfaces
2. Wheels 7. Flanges
3. Tracks and Trackage 8. Roadbeds
4. Rail, Materials 9. Brakes and Braking
5. Rail, Rolling Stock 10. Vibration

Abstract: The report assesses the variety of studies performed on noise reduction at the steel wheel-rail interface, and recommends an RD&D program for further testing of noise generation and suppression of same. Specifically, the report notes the lack of uniformity in such previous testing and the resulting need for quantitative data from which solutions can be synthesized.

The author begins with a discussion of background information, citing areas of previous research, and follows with a thorough analysis of noise generation at the steel wheel-rail interface. The latter is caused by vibration which is, in turn, caused by a combination of forces on the wheel's tread, flange, and hub. Three specific sources of vibration are considered including tread impact, tread sliding, and flange rubbing.

The report also enumerates 15 techniques for noise suppression. These include redesigns of the wheel, redesigns of the rail, smooth tread surfaces, redesigns of the drive shaft mechanism, redesigns of the braking system, and application of damping materials and coatings to rails, trackbeds, and wheel surfaces.

The report concludes with a recommended RD&D program for further investigation of the noise-suppression techniques including theoretical analysis of the techniques, laboratory evaluation, and final demonstration of a "quieted" rail car prototype. Time and cost estimates for the RD&D proposal are suggested.

NTIS Order #: PB-178-256
PC \$3.00, MF 95¢

Title: "Unconventional Heat Engines for Urban Vehicles -- Monograph #16"

Author: J. A. Hoess (Battelle Memorial Institute)

Date: October, 1967 Proj. #: 3-NSS-3

Keywords: 1. Propulsion System, Internal Combustion
2. Propulsion Systems, External Combustion
3. Propulsion System, Turbines
4. Propulsion Systems, Diesel
5. Propulsion Systems, Electric
6. Propulsion Systems, Hybrid
7. Fuel, Types
8. Mufflers
9. Air Pollution

Abstract: The report assesses variations of and alternatives to conventional internal combustion propulsion systems for urban vehicles with particular regard to reduced exhaust emissions. The author notes a general lack of research in this field by private industry, particularly for application on automobiles, and recommends a publicly-funded RD&D program.

The discussion of alternative propulsion devices touches on both refinements of the internal-combustion principle and on altogether different systems. Such alterations of the conventional engine include modification to use diesel fuel and use of fuel-injection, unleaded gasoline, catalytic mufflers, and exhaust recycling devices.

Several unconventional heat engines are also discussed including gas turbines and external combustion systems. Other alternatives, including various energy storage and conversion, direct thermal to electrical energy conversion, and hybrid systems, are listed.

Throughout, the author confines his analysis to the exhaust emission levels of each system, and does not consider other performance characteristics.

NTIS Order #: PB-178-257
PC \$6.00, MF 95¢

Title: "Potential Application of the Helicopter in Urban Mass Transportation --
Monograph #18"

Author: J. P. Loomis (Battelle Memorial Institute)

Date: October, 1967

Proj. #: 3-NSS-3

Keywords: 1. Aircraft, VTOL
2. Private Transportation,
Taxicabs
3. Intermodal Competition
4. Noise and Noise Control
5. Weather Effects
6. Aircraft, Traffic Control

Abstract: The report assesses the current feasibility of VTOL (vertical take-off and landing) type machines in intraurban transportation. Attention is given particularly to the immediate competitiveness of helicopters versus taxicabs and to the extent to which this could be increased through research and development.

At this time, it is shown that at 50% load factors, the helicopter could economically compete with taxicabs for stage lengths of 10 miles or more. The seat-mile costs for such stage lengths would be about 34¢ per occupied seat mile. The author analyzes the effects of future research in terms of reducing operating costs and concludes that economically it might be possible to reduce seat-mile costs by as much as 30% and for VTOL's to compete with taxicabs over routes as short as 5 miles. He demonstrates that this would be especially true where the VTOL's operated over fixed-routes.

Despite these economic advantages, however, the author rules the helicopter out as a mass transportation vehicle. Three specific problems are discussed including unacceptable noise levels, air-traffic control difficulties, and the likelihood of frequent service disruptions due to weather.

The author recommends a discontinuation of publicly-funded RD&D for VTOL applications in urban mass transportation.

NTIS Order #: PB-178-258
PC \$6.00, MF 95¢

Title: "Transit Usage Forecasting Techniques: A Review and New Directions"

Author: Consad Research Corporation

Date: April, 1968

Project #: NSS-4

Keywords: 1. Modal Split
2. Vehicle, design
3. Bus, design
4. Ridership, volume
5. Rail, stations and terminals
6. Bus, stations and shelters
7. Benefit-Cost Analysis
8. Community Response

Abstract: The proper design of transit vehicles and stations, and the predicted economics of the transit systems themselves rely heavily on accurate estimates of ridership. This report is directed to the topic of transit usage forecasting - the validity of the present techniques, desired improvements in the techniques, and the implementation of those improvements.

Chapter II contains an intensive review of operational modal split models, supported by evidence derived from a review of the relevant literature on transit usage and personal behavior in modal choice situations. Several critical factors in the modal choice decision-making process are then identified, to the extent possible, to permit their possible use in more refined modal split forecasting models.

Chapter III describes the steps necessary for the development of behavioral modal choice models; consideration is given to both the actual and desired uses of the outputs from modal split models, both in the planning process and in establishing public policy. The emphasis then shifts to a discussion of the basic characteristics of models (their functions, their formulation, and the problems of validation). This is followed by a discussion of cost-effectiveness considerations in model development. Special attention is given to the problems of forecasting the usage of such new public transportation as may exist only in concept at the time of this report. After analyses of data considerations in model development and the practicality goal-seeking modal choice models, an approach to improved modal split modeling is presented.

Chapter IV contains the conclusions and recommendations of the investigation of modal choice forecasting techniques.

NTIS Order #: PB-178-436
PC \$6.00, MF 95¢

Title: "Bi-Modal Urban Transportation System Study: Volume I, Final Report"

Author: Cornell Aeronautical Laboratory of Cornell University, Buffalo, N.Y.

Date: March, 1968

Project #: NSS-5

Keywords: 1. Dual-Mode Systems
2. Guideways
3. Center City
4. Parking, capacity and demand
5. Air Pollution
6. Propulsion Systems, electric
7. Personal Rapid Transit
8. Bi-Modal Systems
9. Traffic, congestion
10. Vehicle, design

Abstract: This report defines and describes a dual-mode vehicle transportation system intended, primarily, for urban-suburban use. The small, 4-passenger, electrically powered vehicle can operate on streets and highways in the manner of a conventional automobile, at which time it draws its power from an internally-stored energy source (battery); the car can also operate on an exclusive, tracked guideway, at which time it is under fully automatic control, drawing its power from a third rail.

Essentially, the guideway is a conventional two-rail track on which the car runs on flanged metal wheels. The author points out that an important difference between this vehicle-guideway system, called the "Urbmobile," and other automated highway systems is that the vehicle contains no speed, headway, or guidance control equipment; this factor appears to contribute significantly to the reliability of the system and reduced cost of the vehicles.

The dual-mode system provides a door-to-door service, without transfer, for the individual who owns a vehicle or rents one; it offers a rapid-transit service for the person who goes to a station and pays the fare to any other station on the guideway network. The guideway system has the potential of carrying traffic volumes of 10,000 or more Urbmobiles per lane per hour (compared to 2,000-2,200 automobiles per lane per hour on an urban expressway). Also, the amount of air pollution ascribed to vehicular traffic should be significantly reduced.

A comparative evaluation is made between the Urbmobile system concept and one in which electrically propelled "pallets" are used to furnish a similar transportation service. The pallets, air-supported and propelled by linear electric motors, operate only on their exclusive guideways, which are located in tunnels approximately 120 feet below the surface, and are always under automatic control. As a result of the evaluation, it was concluded that the principle advantages of the Urbmobile over the pallet system appear to be in lower initial and operating costs for the Urbmobile, and the Urbmobile's relief of parking and traffic congestion and reduction of air pollution in the central city area. Further, the Urbmobile system can be expanded to intercity service at a much lower capital cost than can the pallet. The most notable advantage of the pallet over the Urbmobile, the author states, is that the individual vehicle owner can make full use of the system, on its implementation, without having to invest in a new, and special, vehicle.

As a result of the studies, the report ends with a set of recommendations for four phases of effort toward the attainment of an Urbmobile system in a suitable city. The first phase of work that is suggested is a study to expand the scope and refine what is covered in this report; the phase of effort suggested to follow is to construct a small experimental facility, so that full-scale prototype equipment can be built and tested to determine or prove the operating and performance characteristics of the components. Phase 3 would be a demonstration project to realize public reaction to the system, and the last phase would be the construction and placing into service of a complete Urbmobile system to serve a metropolitan region.

Title: "Bi-Modal Urban Transportation System Study; Volume II - Technical Appendices"

Author: Cornell Aeronautical Laboratory of Cornell University, Buffalo, N.Y.

Date: March, 1968

Project #: NSS-5

Keywords: 1. Bi-Modal Systems
2. Dual-Mode Systems
3. Guideways
4. Personal Rapid Transit
5. Propulsion Systems, electric
6. Highway, planning

Abstract: This report, Volume II of the Bi-Modal Urban Transportation System Study, is a collection of technical memoranda that were written by various authors during the course of the project.

The articles are primarily concerned with various aspects of the "urbmobile," a dual-mode vehicle transportation system intended mainly for urban-suburban use. The small, 4-passenger, electrically powered vehicles can operate either on streets and highways in the manner of a conventional automobile, or on exclusive, tracked guideways. Each of the memoranda, the author points out, was intended to document some distinct related portion of the overall study effort.

The author states that the appendices are presented somewhat in the order in which they were written, chronologically. Explanations at the lay level, he notes, are minimal as it was assumed that the reader interested in the work presented in the report would not be the layman, but rather the technically oriented engineer or researcher. The author adds that editing of the appendices was confined to the elimination of errors and assurance of sufficiency of factual information to establish communication to the reader.

NTIS Order #: PB-179-192
PC \$6.00, MF 95¢

Title: "Bi-Modal Urban Transportation System Study; Volume III - Addendum - Technical Appendices"

Author: Cornell Aeronautical Laboratory of Cornell University, Buffalo, N.Y.

Date: May, 1968

Project #: NSS-5

Keywords: 1. Bi-Modal Systems
2. Dual-Mode Systems
3. Suburbs
4. Guideways
5. Center City
6. Personal Rapid Transit
7. Parking, capacity and demand
8. Benefit-Cost Analysis
9. Highway, types
10. Traffic, flow

Abstract: This report is an addendum to Volume II, Technical Appendices, of the Final Report on the study of the Urbmobile design concept. The Urbmobile is a dual-mode vehicle transportation system intended primarily for urban-suburban use; the small, 4-passenger, electrically propelled vehicle can operate either on streets and highways in the manner of a conventional automobile, or on exclusive, tracked guideways. The results of four brief tasks related to the Urbmobile are reported in five appendices.

The first appendix shows some comparison between costs for an urban expressway and an Urbmobile guideway of at least equivalent traffic capacity. In the second memorandum, parking area requirements in the center city using an automobile-dependent transportation system are compared to parking requirements using a mix including Urbmobiles and automobiles. The third paper describes an economic comparison between the highway system proposed for the Niagara Frontier to meet the travel demands of 1985, and a 126-mile Urbmobile guideway system designed to meet the same demand. Levels of service of expressway and Urbmobile guideway systems proposed for the Niagara Frontier are compared in the fourth appendix, which concerns itself with the total area coverage in the Niagara Frontier in the post 1985 period. The final article is concerned with the problem of traffic distribution in the immediate vicinity of an Urbmobile guideway station.

NTIS Order #: PB-179-193
PC \$6.00, MF 95¢

Title: "Analysis and Requirements of Electronic Command and Control Systems"

Author: General Electric Company

Date: November, 1967

Proj. #: NSS-6

-
- Keywords:
- | | |
|------------------------|------------------------------|
| 1. Meters and Metering | 5. Corridors- |
| 2. Traffic, control | 6. Traffic, flow |
| 3. Sensors | 7. Demand Responsive Systems |
| 4. Instrumentation | 8. Bus, priorities |
-

Abstract: The purpose of this report is to describe the second phase of a study conducted for the United States Department of Housing and Urban Development on electronic command and control systems as methods of improving urban transportation. Results of the survey conducted under Phase I of this study were analyzed to identify deficiencies and problem areas in the existing systems. Based on this analysis, the current report describes classes of command and control systems that show the most promise in coping with the problems and deficiencies of existing and proposed future urban transportation systems.

Some general principles that were considered in identifying problem areas and deficiencies were enumerated: (1) Urban transportation has one principal function - moving people where they want to go, when they want to go. (2) Urban transportation must be evaluated against a number of criteria such as cost, travel time, reliability of service, public acceptability, safety, comfort, and convenience. (3) Most existing modes of urban travel involve vehicles moving over rights-of-way.

The general approach followed for each subject considered was to first present an analysis and a discussion of the problems and the present control systems, and to then propose a suggested optimum or improved class of system. In accordance with the provisions of the contract, the main concern is with systems which can be brought into use in the near future, and the main emphasis is on the command and control aspects of such systems.

In the section Urban Traffic Control Systems, a discussion of both European and American traffic control systems for large cities is given. The "Advanced System" proposal here includes, in addition to the best features of existing systems, such concepts as Urban Core Metering, Variable Routing, Improved Driver Advisories, and an advanced technique of Destination Sensing. Under Urban Expressway Control Systems, a discussion is given of Merging Control, Ramp Metering, and Expressway Corridor Control Systems; the last involves the integration of traffic on expressways with traffic on neighboring arterials. The suggested Advanced System discussed meets the requirements of a composite system in performing all these functions. The section Metropolitan Transportation System Control discusses the intermodal synchronization problem. The report also contains research on bus priority systems and demand actuated transit systems.

NTIS Order #: PB-178-283
PC \$6.00, MF 95¢

Title: "A Study of Command and Control Systems for Urban Transportation"

Author: General Electric Company

Date: February, 1968

Project #: NSS-6

Keywords: 1. Quantitative Analysis 7. Demand-Responsive Systems
 2. Qualitative Analysis 8. Intersections and Crossings
 3. Safety 9. Guides and Guidance
 4. Management 10. Maintenance, facilities
 5. Communications 11. Vehicle, monitoring
 6. Bus, priorities 12. Traffic, control

Abstract: The objective of this study project was to explore promising transportation command and control systems for future research, development, and demonstration programs. Classes of command and control systems were generated and then evaluated with regard to overall performance, potential performance improvement, adaptability to changing transportation needs, compatibility with other parts of the command and control system, reliability in terms of life and accuracy, maintenance requirements in terms of manpower skills, sensitivity to environment, and overall cost including estimates of installation and maintenance costs.

Ten candidate command and control research, development, and demonstration projects emerged as those with the most promise for effecting improvements in urban transportation: Demand-Actuated Route Transit, Expressway Bus Priority, Microelectronic Intersection Computer, Automatically Controlled Guided Vehicle, Advanced Train Separation, Safety Check-out and Performance Monitoring, Passenger Loading and Unloading, Overall Metropolitan Transportation Control, Vehicle Storage and Retrieval, and Optical Communication and Ranging Systems for Traffic Control. The ten projects are summarized in the report; in addition, an analysis of command and control system characteristics, identification of command and control problem areas, possible system configurations, value effectiveness studies, and research, development, and demonstration program schedules are presented for each project.

A study to develop a "Framework for Evaluation of Transportation Systems" was performed concurrently with the reported project; the results of that study effort are presented in Part 3 of this report. In Section I of Part 3, the parts or functions of a generalized transportation system are delineated as the transportation process, information sensors and conditioners, control alternatives, and actuating devices. Methods for evaluating the value or worth of a transportation system are presented in Section II. The time phase or extent of change is described in Section III with regard to the present process, intermediate process, and new process. In Section IV, criteria for evaluating the effect of changes are listed, and several system problem areas are delineated in Section V. The framework outlined in the sections preceding Section VI is demonstrated using a sample transportation system.

NTIS Order #: PB-178-281
PC \$6.00, MF 95¢

Title: "Survey of Electronic Command and Control Systems"

Author: General Electric Company

Date: August, 1967

Project No. NSS-6

Keywords: 1. Instrumentation 5. Fare, collection
 2. Communications 6. Computer, applications
 3. Management 7. Routes and Routing
 4. Sensors 8. Quantitative Analysis

Abstract: The report, one of a series of studies undertaken to determine the basis for research and development programs in urban transportation, examines command and control systems. The analysis considers fixed-guideway vehicles such as commuter and rapid transit cars as well as roadway vehicles such as private automobiles, taxis, and buses.

Command and control systems refer to electronic devices which, in a broad context, include lasers, transponders, radar, computers, and other advanced means of controlling vehicles. The systems of command and control embrace the following functions: (1) sensing to acquire data on location and classification of vehicles and to make measurements of traffic conditions; (2) communication to transmit data to central processing facilities; (3) analysis of data to allow decision-making with either automatic or manual strategy-selection processes; (4) communication of commands to execute control of vehicles either automatically or through driven advisory equipment; and (5) automatic fare collection and inventory systems.

This report describes a comprehensive survey conducted of state-of-the-art command and control systems for urban transportation vehicles. The author notes that a thorough search was conducted of all applicable non-proprietary published and unpublished documents available. In addition, extensive visits were made to several cities to survey various systems in operation.

The types of systems surveyed include: data requisition, vehicle control, priority and routing, supervisory, inventory, and fare collection. The report is also broken down into two major sections -- Urban Roadway and Urban Guideway. An appendix and bibliography are also provided.

NTIS Order #: PB-178-282
PC \$6.00, MF 95¢

Index No. 3-NSS-6.3

363

Title: "New Systems Implementation Study - Volume I: Summary and Conclusions"

Author: General Motors Research Laboratories

Date: February, 1968

Proj. #: NSS-7

Keywords:	1. Qualitative Analysis	5. Social Benefits and Costs
	2. Quantitative Analysis	6. Benefit-Cost Analysis
	3. Vehicle, design	7. Community Response
	4. Modal Split	8. Computer, applications

Abstract: This report is published in three volumes; this, Volume I, is intended, the author says, for the reader who desires a summary only and prefers not to pursue the procedures and results of the study to the level of the technical detail contained in the remaining volumes.

The primary purpose of the Implementation Study is to outline and recommend a program of research leading to new and improved methods of transportation systems planning and evaluation. The research recommendations are concerned with: (1) transportation requirements analysis, (2) system design and analysis, (3) mode demand estimation, and (4) socio-economic evaluation.

The recommendations for Transportation Requirements Analysis include a deficiency analysis, a travel demand estimation, commodity movement forecasting, and investigation of various indirect requirements. The needs for a catalog of urban transportation modes, a reference source for technological information of the status of subsystem technology, and improved methods of system design and analysis computer programs comprise the bases for the recommendations in the area of System Design and Analysis. The recommendations in Mode Demand Estimation stress research into mode choice in the areas of individual and social psychology, and improved methods of network programming. Recommendations for Socio-Economic Evaluation encompass: (a) the difficulty in attaching dollar values to such indirect requirements as reduced air pollution, improved aesthetics, or a changed land-use pattern; (b) the need to develop further analytical tools for optimizing a given system with respect to its control parameters (such as fares), and, also, the need to provide a measure of the net benefit to society of the system; (c) the need for more major research toward the development of systematic theory in the processes of urban and regional development, and the need for more use of computer techniques and experiments in urban structure and change; (d) the need for studies of the costs and benefits of government organizations that can accomplish the goals of total urban planning; and (e) the need for more information on how net benefits of new transportation systems are distributed.

An analysis of the tasks of urban transportation systems planning and evaluation resulted in a recommended approach toward a family of methods of planning and evaluation; the use of such methods is applied to seven case studies, each considering a specific transportation need in order that several different transportation needs in various size urban areas can be studied. For each case study, a different new system concept is chosen; each case study outlines the purpose of the new system and then proceeds to describe a possible design in sufficient detail to determine whether the new system is practical from an economic and aesthetic point of view. An Implementation Plan is provided in each case study, including a time schedule and budgetary estimate for each task (This is an outline of the programs which would have to be undertaken in order to put the new system into operation in a particular urban area.). The new system then undergoes a critical analysis, which includes the prospective rider's probable reactions to the new system and the general impact of the new system on a community, relative to the specific urban area and need.

NTIS Order #: PB-178-273
PC \$6.00, MF 95¢

Index No. 3-NSS-7.1

364

Title: "New Systems Implementation Study - Volume II: Planning and Evaluation Methods"

Author: General Motors Research Laboratories

Date: February, 1968 Proj. #: NSS-7

-
- Keywords: 1. Quantitative Analysis 4. Social Benefits and Costs
2. Qualitative Analysis 5. Urban Development, planning
3. Modal Split 6. Benefit-Cost Analysis
-

Abstract: This report is published in three volumes. This, Volume II, is concerned with methods for transportation planning and evaluation. It includes status reports on advanced techniques for predicting future travel demand and new system ridership, together with procedures developed in this study for evaluating and comparing proposed new systems in terms of their social impact upon communities. This volume also contains detailed appendices relating to analytical techniques, design and analysis methods, and technical references.

Research recommendations are discussed as they apply to the general categories of Requirements Analysis, System Synthesis and Analysis, Mode Demand Estimation, and Socio-Economic Evaluation. Requirements Analysis is viewed conceptually as the link between the urban planning model and the socio-economic and engineering models of the transportation system, comprising both the translation of urban goals into transportation and land use objectives, and the translation of these objectives into transportation system requirements; the existing transportation system is evaluated with regard to the various requirements and its shortcomings are determined (If significant system deficiencies are identified, the author states, implementation of new or adapted modes of transportation or simply the expansion, in some way or another, of the existing modes is considered.). System Synthesis and Analysis begins with a consideration of the technical feasibility of a proposed mode or system and culminates in detailed performance and cost estimates developed as socio-economic attributes of the proposed mode (including such attributes as travel time, waiting time, and transfer requirements, rather than engineering characteristics such as weight and horsepower). Mode Demand Estimations involve research directed toward the study of individual travel behavior viewed in relation to the choice mechanisms employed by individual decision units in a selection of destination points, alternative routes, trip scheduling and travel mode, as well as consideration to the effect of certain constraints (social, behavioral, economic) placed on such behavior for different units, and consideration to the development of a more efficient method for aggregating responses of different classes of travelers. The Socio-Economic Evaluation process includes the analysis of user costs and benefits (to both travelers and freight movers), the analysis of indirect costs and benefits, and the evaluation of the economic or financial feasibility of the system (the subsidy requirements, if any).

In order to illustrate the extent to which suitable analytical techniques are already available and to identify the areas in which new or improved analytical techniques are needed, actual case studies are used; the results are the identification of those analytical tools which appear to be most needed by transportation planners and which form the basis for the recommended program of research described in the report.

NTIS Order #: PB-178-274
PC \$6.00, MF 95¢

Title: "New Systems Implementation Study - Volume III: Case Studies"

Author: General Motors Research Laboratories

Date: February, 1968

Project #: NSS-7

Keywords: 1. Qualitative Analysis 5. Trip Generation
 2. Quantitative Analysis 6. Community Response
 3. Surveys 7. Demography
 4. Modal Split 8. Ridership

Abstract: This report is published in three volumes. This, Volume III, is comprised of a series of case studies intended to illustrate the approach to the implementation of new systems. The objective of the case studies is to apply, insofar as practical, planning and evaluation methods (outlined in Volume II) to the transportation needs of several urban areas. The author states that since such new and improved methods are only partly available in operational form, less thorough methods had to be employed in the case studies.

Several urban areas were investigated to select the sample urban areas for the case studies (This was done to ensure that examples were chosen which were representative of major transportation requirements, and to ascertain the existence of recently completed origin and destination studies in each selected area.). In each of the urban areas, the most urgent transportation needs were defined with the help of local planners and by field surveys. For each need, quantitative data on travel demand and current mode choice was obtained; then, a mode concept was selected to meet that need.

The author reports on seven case studies, each considering a specific transportation need in order that several different transportation needs in various size urban areas can be studied. For each case study, a different new system concept is chosen; each case study outlines the purpose of the new system and then proceeds to describe a possible design in sufficient detail to determine whether the new system is practical from an economic and aesthetic point of view. An implementation plan is provided in each case study, including a time schedule and budgetary estimate for each task (This is an outline of the programs which would have to be undertaken in order to put the new system into operation in a particular urban area.). The new system then undergoes a critical analysis, which includes the prospective rider's probable reactions to the new system and the general impact of the new system on a community, relative to the specific urban area and need.

NTIS Order #: PB-178-275
PC \$6.00, MF 95¢

Title: "Systems Analysis of Urban Transportation - Volume I: Summary"

Author: General Research Corporation

Date: January, 1968

Project #: NSS-8

Keywords: 1. Quantitative Analysis 3. Benefit-Cost Analysis
 2. Qualitative Analysis 4. Social Benefits and Costs

Abstract: This volume is one of four that make up the final report of a study, one of several, investigating technological innovations in urban transportation; the emphasis of this study was on comprehensive, quantitative evaluation of alternative paths to major improvements in urban transportation and in related qualities of urban life. This, Volume I, summarizes and interprets the essentials of the analysis, with consequent recommendations for research, development, and demonstration; appendices include a guide to study organization and to the 44 individual research papers produced as each study task was completed.

The author states that the fruits of modern technology can be joined in a variety of new transportation systems, all of which improve on the present but which differ in cost and development time, in the breadth and depth of improvement, and in the degree to which various segments of the population would benefit. The innovations of modern technology tend to fall into two classes: (1) one consisting of individual improvements which could be applied piecemeal to existing transportation modes, and (2) one involving essentially new transportation forms made possible by the new technology. These two classes, the author explains, leads to a fundamental problem of policy: Should primary development emphasis be placed on gradual, incremental changes in and additions to current automobiles and public transit, or should it be directed to the innovative forms of new technology?

To clarify the consequences of these alternative policies, this report presents analyses of their consequences. Section II outlines the major technological possibilities. Sections III and IV analyze the performance of the transportation systems that would become available were one or the other of these policy alternatives followed. Section V compares these results with respect to service provided and the attendant economic and social costs and benefits. In Section VI, a \$100 million research, development, test and demonstration program is outlined which, in five years, the author forecasts, would confirm the feasibility of new transportation forms and provide the bases for their widespread implementation in the ensuing decade.

NTIS Order #: PB-178-261
PC \$6.00, MF 95¢

Title: "Systems Analysis of Urban Transportation - Volume II: Cases for Study"

Author: General Research Corporation

Date: January, 1968

Project #: NSS-8

Keywords: 1. Quantitative Analysis 4. Private Transportation, automobiles
2. Qualitative Analysis 5. Computer, applications
3. Demography 6. Social Benefits and Costs

Abstract: This volume is one of four that make up the final report of a study, one of several, investigating technological innovations in urban transportation. The scope of the study was limited to innovations for the period three to fifteen years in the future, and its emphasis was on comprehensive, quantitative evaluation of alternate paths to major improvements in urban transportation and in related qualities in urban life. The study's goal was to devise a plan for research, development, and demonstration. This, Volume II, is a collection of research papers on the selection and representation of typical cities and of promising transportation innovations for further analysis.

Under the terms of the study contract, the author was to select three cities to serve as case studies of urban transportation problems and solutions for the future; this study was undertaken in order to make the selection of the three case cities as objective as possible. It was decided that two of the case studies should be large metropolitan areas; it was also decided that one of the large urban areas selected should be "automobile-oriented," while the other should be "transit-oriented." It was further decided that the third case city should be a medium-size city, since so many cities in the United States are in this range and display different urban transportation problems; this city, containing in its metropolitan area at least enough residents to permit reasonable traffic flows between zones so that use could be made of the author's computer network flow and trip generation models, was defined as follows: (1) It should be located in a Standard Metropolitan Statistical Area (SMSA) having a population between 200,000 and 400,000. (2) Its central city should have a population of at least 100,000.

Twenty-four SMSA's qualified as candidates for one or the other large-city case studies; 43 SMSA's qualified in the medium-city category. Having limited the range of selectivity to 67 urban areas, the problem came down to choosing a methodology for making the selections. A combination of regular correlation analysis and factor analysis was chosen because they seemed to offer the most effective bases for comparison.

On the basis of the correlation and factor analyses of the 24 large urban areas, it was found that six cities offer the best representation of automobile-oriented cities and four cities offer the best representation of transit-oriented cities; ultimately, the author notes, the choice of cities will depend on criteria additional to those employed in the preliminary analyses. In the medium-size city category, it was not possible to differentiate the areas on the basis of the transportation factor as, while there was some use of public transportation, all the areas tended to be heavily oriented toward the automobile; however, 12 areas appear to be the most representative of the 43 urban areas in the medium-size city category.

This volume reports on how the representative groupings were derived and why the author feels that they offer the best range for further selection for the case cities in each category.

NTIS Order #: PB-178-262
PC \$6.00, MF 95¢

Title; "Systems Analysis of Urban Transportation - Volume III: Network Flow Analyses"

Author: General Research Corporation

Date: January, 1968

Proj. #: NSS-8

Keywords:	1. Quantitative Analysis	5. Benefit-Cost Analysis
	2. Qualitative Analysis	6. Computer, applications
	3. Poverty	7. Trip Generation
	4. Employment	8. Social Benefits and Costs

Abstract: This volume is one of four that make up the final report of a study investigating technological innovations in urban transportation. The scope of the study was limited to innovations for the period three to fifteen years in the future, and its emphasis was on comprehensive, quantitative evaluation of alternate paths to major improvements in urban transportation and in related qualities of urban life. The study's goal was to devise a plan for research, development, and demonstration. This Volume III is a collection of research papers on the quantitative evaluation of basic transportation performance and of a comprehensive set of associated costs and benefits.

The network flow analyses derive basic relationships concerning the spatial distribution of various occupational categories; those categories particularly relevant to disadvantaged urban groups are identified, and a refined measure of employment accessibility for a particular example is developed.

Statistics available concerning the prevailing occupational distribution of employment for some disadvantaged groups indicate, the author states, an equilibrium condition between prevailing supply and demand relationships in each of the occupational sectors for each case city. The relative distribution of employment reflects the net effect of differences among the sectors in simple (purely economic) supply and demand for labor, together with differences in transportation accessibility, and in the effects of discrimination in employment. The task of this particular study was to develop measures of the spatial distribution of job opportunities and to relate these to transportation service. Purely economic considerations indicate that the poorly trained and poorly educated will be employed primarily as operatives, laborers, and service workers; a measure of transportation services is, therefore, accessibility (in terms of transportation) to jobs in these categories.

The basic focus of this paper is methodological. A technique of analysis is suggested and is applied to results of computer analyses of the author's case cities. The technique is generalized, the author states, in that it is based upon a general, statistical relationship among variables; further, present distributions of employment opportunities and disadvantaged urban groups are used to evaluate future transportation systems. In the absence of detailed statistics within a particular city of particular employment and population distributions, a model, considered by the author to be a useful and meaningful tool, is set forth in the paper.

NTIS Order #: PB-178-263
PC \$6.00, MF 95¢

Title: "Supplemental Studies of Urban Transportation Systems Analysis"

Author: General Research Corporation

Date: September, 1968

Proj. #: NSS-8

Keywords:	1. Modal Split	4. Quantitative Analysis
	2. Rail, systems planning and design	5. Distribution Systems
	3. Ridership, volume	6. Land Use

Abstract: The purpose of this report was to present three sets of studies concerned with: (1) alternative land uses and travel demand, (2) extended rail rapid transit systems in Boston, and (3) improved modal split formulations. This volume supplements an earlier study (Phase I) which was conducted to investigate new technological innovations in urban transportation.

The first study examined two new patterns of travel demands which focused upon increased suburban nucleation and increased central focus. Tests of these new demands against key transportation systems indicated that the performance of those systems was affected only slightly by the new demands.

The second study analyzed the performance of two rail rapid transit extensions in Boston. The systems have 95 route miles and 137 route miles, respectively. The rail extensions were tested by using network flow simulation. The results of the simulations were tested against a projected travel demand for Boston in the year 1975, and were compared with results for the basic 61 mile rail system (Phase I). The comparisons revealed that the extended systems produced small but measurable improvements in total system performance and public transit patronage, although public transit costs per delivered passenger-mile increased markedly.

Two studies of modal split formations were included in the last report. The first examined a new mathematical formulation, and determined that only a modified version can be specified with the available empirical data. The second modal split study employed a special calibration procedure. The study was somewhat inconclusive, but it did note that passenger collection and distribution services must be greatly improved to yield increased patronage.

NTIS Order #: PB-179-865
PC \$6.00, MF 95¢

Title; "Special Transportation Requirements in Small Cities and Towns"

Author: Midwest Research Institute

Date: May, 1968

Proj. #: NSS-9

Keywords:	1. Small Cities	4. Ridership
	2. Demography	5. Traffic, flow
	3. Urban Development, planning	6. Financing Mass Transportation, re- quirements

Abstract: The purpose of this report is: (1) to analyze the special transportation needs of small cities; (2) to identify the need for and potential means of adapting to changing local demand patterns; and (3) to indicate those areas in which further research, special studies, and demonstration projects could be fruitful.

A comprehensive and systematic approach was followed in developing this broad-gauged project. Relevant current studies, reports, and literature were reviewed and analyzed. The transportation and comprehensive planning of 58 selected small cities and towns, representing a cross section of the various types and sizes of small cities, were studied. Fourteen selected small cities across the country, representing various population ranges, were visited. For the purpose of this study, small cities and towns are classified into three general types: (1) non-satellite or independent cities - cities located beyond the limits of a Standard Metropolitan Statistical Area (SMSA); (2) satellite cities - those cities located inside a SMSA or those that have relatively strong social, economic, and cultural ties to a central city; and (3) the bedroom communities - predominantly residential suburbs or small cities, including all communities with populations of less than 50,000.

In 1960, there were 19,457 small cities. During the last ten years, the small cities have had a faster growth rate than the national average. Their percentage of total United States population has increased from 29 percent in 1950 to 32 percent in 1960. Population characteristics and growth trends were found to strongly influence local traffic demand patterns. In most small cities, transportation problems have been intensified by the movement of residents from rural-agricultural areas to the cities and, also, by the shift of populations from central cities to suburbs. A thorough review and analysis of transportation planning revealed the following principle problem areas common to most small cities: (1) Few local transportation plans consider future regional traffic demands. (2) Coordination with transportation planning and development programs of other agencies is lacking. (3) Generally, the methods of implementing transportation plans are inadequate. (4) The ability to maintain a professionally trained staff to carry out transportation planning and development programs is frequently limited. (5) Steadily declining use of public transit services has resulted in declining and inadequate service. (6) Privately owned and operated public transit operations have proven to be infeasible; new methods of financing these operations must be developed.

The author recommends the following research studies, action programs, and demonstration projects to facilitate the achievement of solutions to these cities' transportation problems: (1) evaluation of traffic restriction techniques and operational control systems and their applicability for improving traffic flow in small cities; (2) identification and analysis of potential methods of providing transportation information and technical assistance to small cities; (3) analysis of the impact of social and economic developments on public transit in small towns; (4) determination of improved methods of meeting financial requirements for transportation planning and development in small cities; and (5) evaluation of the implications and impact of changing population and employment trends on the transportation requirements in small cities.

NTIS Order #: PB-178-280
PC \$6.00, MF 95¢

Title: "Frontiers of Technology Study -- Volume I: Summary"

Author: North American Rockwell, Los Angeles Division

Date: January 5, 1968

Proj. #: NSS-10

Keywords: 1. Research Operations 4. Air Cushioned Vehicles
 2. Propulsion Systems 5. Tunnels and Tunneling
 3. Aircraft, VTOL

Abstract: The objective of this study was to identify technology, particularly defense and space technology, transferable to transportation needs and to delineate implementation requirements. The study emphasis is on producible and usable hardware for application in the 1973-80 time period.

The study was divided into three functional tasks: the review of technology, the screening of technology, and the assessment and description of implementation requirements. The review task was directed toward providing a firm data and information base for the study with the objective of identifying advanced technologies, scientific principles, and techniques which can find practical application to urban transportation. The screening task was based on the application of evaluation criteria to the technologies disclosed in the review task. The third task was conducted to assess implementation requirements for those technologies surviving the screening task. Fourteen of the more significant areas of technology were defined in this task. Studies were conducted of the implementation requirements that are prerequisite to the transfer of these technologies to usable urban transportation hardware.

The technologies surveyed were: propulsion, energy storage, command and control, tunneling, bioengineering, non-skid braking and traction, advanced suspension, non-contact power transmission, superconductivity, materials and processes, air cushion technology, VTOL technology and computerized maintenance.

NTIS Order #: PB-178-270
PC \$6.00, MF 95¢

Title: "Frontier of Technology Study -- Volume II: Survey"

Author: North American Rockwell, Los Angeles Division

Date: January 5, 1968

Proj. #: NSS-10

Keywords:	1. Research Operations	6. Computer, applications
	2. Surveys	7. Air Pollution
	3. Brakes and Braking	8. Tunnels and Tunneling
	4. Batteries and Cells	9. Traffic, control
	5. Sensors	10. Suspensions
		11. Fuel, types

Abstract: The purpose of this report was to review the existing technology, particularly in defense and space-oriented fields, which would be transferable to the transportation needs of the years 1973 through 1980.

A literature review was conducted through the Western Research Application Center. The WESRAC literature review service provides the listing of citations and abstracts of reports and publications, on any requested subject, in the NASA data bank. In addition, the North American Rockwell Corporation in-house Technical Information Processing System (TIPS) was used, to a limited extent. Literature searches were completed on the following subjects: Braking for Electric Highway Vehicles, Energy Sources for Electric Highway Vehicles, Thermodynamic Cycles Applicable for Vehicle Propulsion, Vehicle Suspension Systems, Mobile Power plant Technology, Nonpollutant Combustion Processes, Wireless Transmission of Power, Man-machine Dynamic Simulation, Superconducting Power Transmission, Natural Computer Language, Traffic Display and Control Techniques, Closed Cycle Steam Systems, Liquified Petroleum Gas, Batteries as Power Sources, Fuel Cells as Power Sources, Sensing Devices for Traffic Control, Nuclear Propulsion for Ground Vehicles, Tunnelling Techniques, Advanced Roadbuilding Materials, and Tires for Highway Vehicles.

An extensive field survey was conducted to aid in identification of potentially transferable technologies. A comprehensive list was developed, which detailed possible sources of up-to-date information of the various subjects selected. Travel logistics were applied to narrow the inventory down to the potentially most promising sources which were then surveyed within the timing and funding limitations of the program. It was decided that five information sources be included in the survey: (1) the academic community, (2) the defense industry, (3) Federal bureaus, (4) the military, and (5) public transit operators. A nationwide survey was conducted which lasted 4 1/2 months. Discussions were held with 300 officials in 17 universities and research organizations, 45 federal government organizations, 16 industrial organizations, and six regional authorities. The appended material lists the major sources of expertise for the technological areas.

NTIS Order #: PB-178-271
PC \$6.00, MF 95¢

Title: "Frontiers of Technology Study - Volume III: Implementation Requirements Studies"

Author: North American Rockwell, Los Angeles Division

Date: January 5, 1968

Project #: NSS-10

Keywords: 1. Research Operations 6. Noise and Noise Control
 2. Air Pollution 7. Batteries and Cells
 3. Power Distribution 8. Brakes and Braking
 4. Propulsion Systems 9. Computers, programming
 5. Qualitative Analysis 10. Budgets and Budget Planning

Abstract: The objective of the Frontiers of Technology Study was to identify technology, particularly in defense and space-oriented fields, which would be transferable to 1973-80 urban transportation needs and to delineate implementation requirements. The study was divided into three functional tasks: Review of Technology, Screening of Technology, and Assessment and Description of Implementation Requirements; the results of the study are documented in a three-volume final report.

This volume, Implementation Requirements Studies, deals with the second and third tasks, Volume II having documented the technology review. Major urban transportation objectives are discussed to indicate some of the problems, such as air pollution, noise, and mobility, to which the advanced technology applications presented in the implementation requirement will be addressed. The criteria and rationale used in the technology screening are identified and applied to select the following 14 technological areas for the implementation requirement study: Batteries and Hybrid-Electrochemical Power Sources, Fuel Cells, Closed Cycle Powerplants, Open Cycle Powerplants, Hybrid-Electric Powerplants, Mechanical Energy Storage, Linear Electric Motors, Advanced Propulsion for Rapid-Transit Rail Vehicles, Advanced Braking Systems for Rapid-Transit Rail Vehicles, Advanced Braking Systems for Highway Vehicles, Active Isolation Systems, Man-Machine Simulation, Advanced Computer Language, and Advanced Computer Programming.

Each of these studies describes the present, at the time of this report, state-of-the-art of the technologies being considered, non-transportation applications and research programs from which background information was taken, feasible urban transportation applications, performance comparisons using the new technology, problem areas, advantages, disadvantages, and order-of-magnitude estimates of RD&D schedules and costs. The author states that each study is essentially complete in itself.

In general, Volume III describes methods used for screening technologies and selecting technological areas for implementation requirement studies; discusses current technology status, urban transportation applications, advantages, disadvantages, problems associated with applications, research and development requirements, gross costs, and other factors bearing on the transferability of the selected technological areas; and makes specific recommendations with regard to these areas.

NTIS Order #: PB-178-272
PC \$6.00, MF 95¢

Title: "Implementation Requirements for Four Advanced Urban Transportation Systems"

Author: North American Rockwell Corporation, Los Angeles Division

Date: October 18, 1966

Proj. #: NSS-10

Keywords:	1. Dual Mode Systems	5. Vehicle, design
	2. Personal Rapid Transit	6. Airport, access
	3. Bus, design	7. Guideways
	4. Rail, systems planning and design	8. Joint Development
		9. Benefit-Cost Analysis

Abstract: The report examines requirements for demonstrations of four innovative urban transportation systems with an emphasis on scheduling and funding procedures. The four systems under consideration include: (1) Dual-Mode Bus, (2) Personal Dual-Mode Vehicle, (3) Personal Rapid Transit, and (4) Fast Transit Link Systems. The Dual-Mode Bus employs a conventional motor coach modified to permit manual operation on city streets for passenger pickup and discharge and automatic control on a high-speed guideway in between. The Dual-Mode Vehicle concept is a variation of the latter system, using small, automobile-like vehicles to provide personal transportation under both manual and automated control. The Personal Rapid Transit System would provide individually-programmed modules moving in a combination of linehaul and network service along an automated urban guideway. Finally, the Fast Transit Link concept employs high-speed rail transit in point-to-point service such as airport access. (A line between downtown Washington, D. C. and Dulles Airport is the recommended demonstration route).

Each system is described briefly, along with schematic illustrations of the proposed demonstration guideway and evolutionary model characteristics. For each of the four innovative concepts, at least four alternative design configurations are compared with reference to propulsion, braking, suspension, vehicle control, communications, guideway switching, related facilities, and other features. On the basis of these characteristics, the optimum models were selected for proposed demonstration programs; complete specifications for both vehicles and guideways are included. The purpose of the report was to synthesize scheduling and funding recommendations for hypothetical demonstrations of the four systems.

The report summarizes in detail development schedules and costs along with substantive supporting documentation. Technology utilization is discussed in terms of innovative component concepts used by the four systems. Benefits of the different transit concepts are also outlined according to such evaluative criteria as noise and air pollution, operating costs, safety, system reliability, ride quality and passenger comfort, utility in meeting the wide range of customer demands, convenience, travel time, modal interface requirements, and traffic congestion.

The report concludes with an assessment of simultaneous development of two or more of the proposed systems in combination. The authors note particularly that many component technologies are common to two or more of the systems and that in any accelerated research and development substantial savings of up to \$35 million could be generated by conducting parallel programs. Time and cost requirements for different combinations among the four systems are detailed.

NTIS Order #: PB-183-039
PC \$6.00, MF 95¢

Title; "Projection of Urban Personal Transportation Demand"

Authors: Peat, Marwick, Livingston, and Co.

Date: March, 1968

Proj. #: NSS-11

Keywords: 1. Demography
2. Inner City
3. Private Transportation,
automobile
4. Ridership, volume
5. Trip Generation
6. Urban Development, planning

Abstract: This report develops functional relationships for estimating transportation demand for 1965, and for forecasting transportation demand for 1975 and 1985 for all urbanized areas. The specific classifications of demand that were investigated in this study were: (1) total trips per day, (2) total daily trips by major purpose category, (3) total trips per day by major population characteristics, and (4) average trip distances and times. The report's final objective was the recommendation of a continuing research program based upon the existing needs discovered during the various phases of The Department of Housing and Urban Development's (HUD) studies on Transportation Demand and Land Uses in Urban Areas.

An important feature of this report is the presentation of an integrated set of urbanized area transportation demand forecasts. These forecasts assume a continuation or modest improvement of present technologies and states-of-the-art in urban transportation.

Specific forecasts and findings of this report are that: (1) Classification of urbanized areas by 1965 population and by 1985 population reveals that the 1965 demand in areas having a population of over 1,000,000 is 124,299,000 trips per day; areas in the 250,000 to 500,000 population generate 23,440,000 trips per day. (2) By 1985, the larger group, which should continue to grow, will generate about 282,947,000 trips per day, and the smaller group is expected to generate 48,232,000 trips per day. These increases are 127 percent for areas in the over 1,000,000 population group, and 106 percent for areas with populations between 250,000 and 500,000 persons. (3) The 1965 distribution of urbanized areas within each population group is expected to change dramatically by 1985 as these areas experience unprecedented growth. (4) Assuming work trips to be the primary component of travel demand, increased trip making from 1965 to 1985 will be in direct proportion to increases in working age population. (5) Studies to develop criteria for the functional and structural classification of urbanized areas at the macro level of analysis showed that population was the only effect indicator of urban structure. (6) In quantifying average trip time relationships for all travel modes by trip purpose, it was found that population is highly correlative with, and significant in, the explanation of total average time of all trips, home based works, social and recreation, personal business, and shopping trips. (7) A research program is recommended that will have as its objective the development of travel demand relationships for the major functional subdivisions comprising the urban area.

NTIS Order #: PB-178-276
PC \$6.00, MF 95¢

Title: "Transportation Requirements and Effects of New Communities"

Author: Regional Economic Development Institute, Inc.

Date: May, 1968

Project No. NSS-12

Keywords: 1. New Towns
2. Urban Development, planning
3. Land Use
4. Private Transportation, automobiles
5. Trip Generation
6. Traffic, flow
7. Right-of-Way
8. Demography

Abstract: The report examines urban transportation requirements and problems in comprehensively planned new communities (ie. "new towns"). The factors most likely to affect interactions between the new community and its urban transportation system were also principal subjects for analysis.

The new town of Columbia, Md., was a selected case study. This development was chosen on the basis of its proposed population, acreage, and land use distribution which represents the scale and type of activity necessary to sustain independent new communities. The authors contend that only new towns of Columbia's magnitude can appreciably affect the distribution of projected future urban population growth.

The research focused upon two basic issues: (1) the estimated network traffic flow in 1980 when Columbia reaches full maturity, and (2) the potential impact of public transit operations on internal traffic patterns.

The authors found that residential land use, family income, automobile ownership, and trip length are significant characteristics of the new town which influence trip production and lend themselves to manipulation by urban planners. Greater availability of shopping and commercial facilities will increase the percentage of personal trips that can be made in the pedestrian mode, thereby reducing the demand for automobile ownership. The report also hypothesizes that once families forego the option of owning a second car, persons will further substitute walking trips for automobile transportation. Other conclusions about transportation in new towns are outlined in detail.

NTIS Order #: PB-178-983
PC \$6.00, MF 95¢

Title: "Future Urban Transportation Systems: Descriptions, Evaluations, and Programs --
Final Report I"

Author: Stanford Research Institute

Date: March, 1968

Project No. NSS-13

Keywords: 1. Demand Responsive Systems, 4. Conveyors
 Dial-A-Ride 5. Electronic Vehicle Guidance
2. Private Transportation, 6. Speed and Speed Control
 automobiles 7. Urban Development, planning
3. Guideways 8. Research Operations

Abstract: The purpose of this report was to examine the feasibility of future transportation systems in the light of the technology which can be implemented within five to fifteen years. The report provides extensive research into the concepts of various complementary transportation systems and reaches conclusions as to the systems which are feasible and the requirements for future research.

Major Activity Center (MAC) travel service concepts are conveyor sidewalks which operate at speeds of approximately 15 miles per hour. The major obstacle to implementation of this concept is safety; the authors propose no solution to this problem, but they conclude such a system would provide benefits in excess of research and development costs.

The Public Automobile Service (PAS) is envisioned as a large fleet of small, four-passenger self-propelled cars to provide local and area travel service. The development of durable and dependable PAS cars is the major obstacle to implementation. The Dial-A-Bus concept is not examined in detail, but it is mentioned as a necessary complement to PAS to serve non-drivers.

Extended area travel service is to be provided by an area-wide Network Service (NET). A NET system would consist of small, four to twelve-passenger vehicles which operate under automatic control on a special grade-separated guideway with very short headways. Speeds would be in the 50-70 miles per hour range, and the network would be fine-grained. A NET system which uses somewhat larger vehicles, NET-2 and NET-3, is also explored; the principal obstacle to NET systems and the principal area for research is how to incorporate a NET system into an existing network of city streets.

The authors also recognize the need for Fast Transit Links (FTL) such as between the city and suburbs, airport to city, and satellites to radials. The report recommends that a FTL be a guided air-cushion or tracked vehicle which seats 20-80 passengers at operating speeds of approximately 160 miles per hour. A given example is the Tokaido Line in Japan indicating there are few problems in implementing this proposal.

The new urban transportation systems described in this research are intended to complement one another. Thus, the roles of the new systems for extended area service -- NET and FTL -- should be considered in relation to the roles of PAS and Dial-A-Bus for local area travel and MAC for travel within major activity centers.

NTIS Order #: PB-178-265
PC \$6.00, MF 95¢

Title: "Future Urban Transportation Systems: Impacts on Urban Life and Form -
Final Report II"

Author: Stanford Research Institute

Date: March, 1968

Proj. #: NSS-13

Keywords: 1. Urban Development, planning 5. Land Use
2. Social Benefits and Costs 6. Governments, urban
3. Demography 7. Demand Responsive Systems, Dial-A-Bus
4. New Towns 8. Private Transportation, automobiles

Abstract: The purposes of this study were threefold: to illustrate the joint concepts of revolutionary transportation services and corresponding land usage by formulating a hypothetical future urban area; to describe the public transportation flows in this hypothetical setting; and to provide a broad-based evaluation of the potential impacts of such transportation concepts on the physical, economic, and social character of urban areas.

A metropolitan area of roughly 4 million inhabitants has been hypothesized as it might have developed by the end of this century. Such an area could be the outgrowth of a moderately large urban area currently on the scale of Minneapolis-St. Paul or Pittsburgh. The area takes advantage of postulated advances in transportation technology and comprehensive planning, combined with a large measure of freedom from present day constraints in such areas as local government fragmentation, property taxation, condemnation rights, and multifunctional social and physical program integration. The hypothesized urban form combines the concept of multiple centers within a central urban concentration with the concept of geographically distinct new town development arranged along radials. Half of the area's population is assumed to live in the central concentration identified as the metropolitan city. Geographically distinct new towns house the other half of the area's population.

Analysis of the relationships between the specified urban area demography, transit network characteristics, and design solutions demonstrated that: (1) Transit networks offer the opportunity to develop much of the land within easy walking distance of stations more intensively than is possible with road networks. (2) The success of focusing most specialized development at discrete centers depends greatly on links to and from predominantly low density development. Without such systems as PASS (Public Automobile Service) and Dial-A-Bus furnishing this service, patronage of the longer distance systems would be unable to support the levels of development assumed in the detailed site plans. (3) The choice of elevated versus subgrade rights-of-way should be influenced by the nature and density of the particular environment.

NTIS Order #: PB-178-266
PC \$6.00, MF 95¢

Title: "Future Urban Transportation Systems: Desired Characteristics -- Memorandum Report #1"

Author: Stanford Research Institute

Date: May, 1967

Project No. NSS-13

Keywords:

1. Environment and Environmental Control	6. Surveys
2. Ridership, attraction	7. Right-of-Way
3. Demography	8. Urban Development, planning
4. Center City	9. Quantitative Analysis
5. Modal Split	10. Quality Control
	11. Land Use

Abstract: This report is intended to provide useful common background and research information for the Stanford Research Institute staff to use in subsequent studies generated by NSS-13. It includes a set of assumptions and predictions which summarize predominant views and reasonable expectations regarding the future form and structure of urban areas and urban transportation.

In the discussion of work and residence locations it is generally assumed that no radical changes in the length or pattern of the work week or work year will occur. Also, no innovations in communications, to the extent that the need for movement will be significantly reduced, are assumed. Since major changes in either area would have a major impact on location decisions, on urban form and structure, and on transportation demand, these implications are discussed.

The conclusions reached concerning the future flow of passengers in urban areas were that there will be a continuing diversity of trip origins and destinations; a major share of the research should emphasize systems that will provide a high degree of mobility throughout the urban area. While congestion is at its worst in central business districts (CBD), the relative movement to downtown areas is small and expected to decline, further suggesting that limited effort be placed on CBD-serving circulation and corridor systems. However, the report suggests that the CBD's are becoming more specialized centers of activity and are drawing more heavily on the suburban work force; this indicates the desirability of higher speed systems that will enable commuters to easily live ten to thirty miles from work. Also recognized are the short-duration, non-work trips (less than three miles) for which research should emphasize comfort and convenience.

The basic conclusions reached concerning individual traveler attributes were that the willingness to pay for future systems can be gauged from the payments that individuals are making for their present mode of transit. The perceivable differences in travel time between two alternatives (the so-called Just Noticeable Difference) is between two and five minutes. Safety aspects of a system are primary factors in the minds of some travelers, and these aspects should be given early attention. Factors related to comfort are many and varied, but seat availability and the aesthetic aspects of vehicles and stations are perhaps the most important. That the attributes of convenience are of considerable importance in understanding the predominance of automobile travel is noted, although convenience is difficult to measure. Other aspects of the study include the attributes of system operators, non-travelers, and the trends in social and political attributes.

NTIS Order #: PB-178-259
PC \$6.00, MF 95¢

Title; "Future Urban Transportation Systems: Technological Assessment --
Memorandum Report #2"

Author: Stanford Research Institute

Date: May, 1967

Proj. #: NSS-13

Keywords:	1. Propulsion Systems	6. Aerial Structure
	2. Batteries and Cells	7. Tunnels and Tunneling
	3. Dual Mode Systems	8. Rail, materials
	4. Guideways	9. People Movers
	5. Quality Control	10. Aircraft, VTOL

Abstract: This report is concerned with the collection, review, description, and preliminary assessment of: (1) advanced systems concepts proposed for urban transportation, (2) the technical components from which such systems may be constructed, and (3) technology in general. Principal objectives of the research were to identify and assess technological developments not only in transportation but in related fields to lay the groundwork for formulating a family of transportation systems and to preclude reinvention of components, techniques, and systems that already are available.

Components and systems are assessed simultaneously, but components are discussed first and systems second because knowledge of the components enhances understanding of the systems. A second reason is that it may be desirable to add assessment of additional systems at a later date.

The body of this report is divided into two chapters. One chapter contains detailed discussions of major components or subsystems - their functions, requirements, performance parameters, states of development, and costs when available. The other chapter reviews systems and concepts. These vary in complexity from a simple moving belt to computer-controlled automatic vehicles traveling on a network of tracks.

The authors' recommendations and observations are as follows: (1) Among power supplies and energy sources, electric storage batteries, medium power gas turbines, and diesel compound engines show particular promise for future development. (2) In power trains and propulsion units, new synchronous and linear electric motors stand out. (3) Among support and suspension systems, there is particular interest in air cushion pads and magnetic suspension systems. (4) Of new techniques for the construction of guideways, tunnel boring machines (moles), prefabricated steel, and prestressed, pre cast concrete components are promising. (5) The study of control systems has not produced any significant new breakthroughs. (6) High speed pedestrian conveyors are desirable, but impractical and unsafe at this time. (7) Manually operated single mode vehicles need garages and redistribution devices before they can serve economically and effectively. (8) More study and experimentation on low cost control systems for single mode automatic vehicles operating on a citywide network is recommended. (9) Large single mode vehicle systems will find application where high speed and large capacities are needed. (10) Until the complex control problems of the single mode automobile system have been solved, a low priority should be given to the problems connected with dual mode systems. (11) Urban aircraft are likely to see considerable technical development in the next ten years; however their use will be subject to economic restraints.

NTIS Order #: PB-178-260
PC \$6.00, MF 95¢

Title: "Latent Demand for Urban Transportation"

Author: Carnegie-Mellon University, Transportation Research Institute

Date: May, 1968

Project No. NSS-14

Keywords: 1. Elderly
2. Youth
3. Off-Peak Traffic
4. Poverty
5. Handicapped
6. Information Aids
7. Market Research
8. Advertising and Promotion
9. Schedules and Scheduling
10. Routes and Routing
11. Surveys
12. Qualitative Analysis

Abstract: The report examines latent demands for urban transportation with reference to their sources, measurement, and satisfaction. The authors note that contemporary transportation planning makes extensive use of demand forecasts to determine service parameters and evaluate new systems. Conventional forecasting methodology, however, employs existing ridership data to fashion future projections. These data may exclude an important source of "potential" demand among special groups for whom present service is inadequate. Six such groups were identified, including: (1) elderly persons who cannot or choose not to operate a private automobile, (2) young people, (3) "secondary" employees who do not make peak-hour work trips, (4) poor persons, (5) housewives, and (6) the physically handicapped. The purpose of the report was to assess the potential transportation demands among these groups, suggest a methodology for quantifying those demands, and to synthesize general recommendations for improving transit service.

The mobility problems of each group were analyzed in detail. General prerequisites for the satisfaction of latent transportation demands were then synthesized with reference to: system design, system attributes and amenities, areal coverage, system complexity, information availability, regional accessibility, and cost. The authors suggest a variety of hardware and service modifications, including elimination of "travel barriers", improved off-peak scheduling, comprehensive transit routing, and controlled fare structures.

In addition, the report develops a method for forecasting latent demand based upon behavioral research. The proposed method would view transit usage as the aggregate of many individual decisions, all framed according to common convenience, cost, and other value-oriented criteria. Future research efforts are discussed with reference to data collection procedures, recommended experiments, and modeling. The authors emphasize behavioral and market research studies to assess the impact of promotional techniques in their recommendations.

Appended material is broken down among four general sections, including: (1) behavioral characteristics and attitudes toward public transit; (2) an analysis of bus tour patrons in Allegheny County, Pennsylvania; (3) proposed survey instruments for future analysis; and (4) a suggested urban transportation bibliography.

NTIS Order #: PB-178-979
PC \$6.00, MF 95¢

Title: "Study of Evolutionary Urban Transportation - Volume II:
Appendices 1,2, and 3"

Author: Westinghouse Air Brake Company, et. al.

Date: February, 1968

Project No. NSS-15

Keywords: 1. Industrial and Labor Relations
2. Research Operations
3. Management, planning and analysis

Abstract: The report contains three appendices to a study of evolutionary improvements in urban transportation systems. Appendix I, entitled "Urban Transportation Needs and Trends," provides additional information and data sources used in the preparation of other reports generated by this project. This study attempted to recommend specific types of improved urban transportation systems; a critical aspect in the research involved estimating future urban transportation requirements. Appendix I amplifies the discussion of future needs with detailed statistical and other supplementary material.

The second appendix, "Labor and Financing," deals with labor problems that are likely to be associated with the introduction of innovations in the urban mass transit industry. The analysis emphasizes the role of labor unions and the conditions under which labor will be most likely to react to transit innovations. In this sense, the report covers both workers in public transportation and those employed by related industries.

The third appendix, "A Systematic Program of General Research and Development," outlines: (1) the role of national leadership in urban transportation, (2) the design of a technologically sound urban transportation system, (3) the problems of making a physically sound system operational in specific urban complexes, and (4) the effectiveness of an operational urban transportation system.

NTIS Order #: PB-178-268
PC \$6.00, MF 95¢

Title; "Study of Evolutionary Urban Transportation - Volume III: Appendix 4"

Author: Westinghouse Air Brake Co., et. al.

Date: February, 1968

Proj. #: NSS-15

Keywords: 1. Research Operations 6. Sensors
2. Guideways 7. Demand Responsive Systems
3. Traffic, control 8. Conveyors
4. Traffic, flow 9. Distribution Systems
5. Pedestrians

Abstract: The purpose of this study was to recommend research, development and demonstration tasks for the examination of new transit systems that can be demonstrated in three to five years. The hundreds of new or improved transit systems, subsystems, and other elements considered in the report are divided into three major types of transportation systems: (1) fixed guideway systems, (2) variable guideway and related systems, and (3) supporting systems.

The report examines the development of a people-actuation concept in which traffic signals are actuated to effect equalization of the person-seconds delay among all who pass through signalized intersections. For example, a bus filled with passengers would be given higher priority in the signal timing than a private automobile, since bus delay generally causes greater person delay. Automatic detectors would be used to sense the presence or absence of pedestrians, autos, and buses to achieve an effective allocation of signal time. Five research and development phases were proposed to test the feasibility of this concept. Bus preemption of signals and automatic pedestrian detection and actuation of signals were also studied.

Preliminary analyses indicated that the Demand Actuated Road Transit (DART) concept merits a full program of research, development and demonstration. The authors selected Los Angeles and San Francisco as potential test locations. The purpose of the tests would be to determine the passenger demand for each of the possible types and levels of DART service. The estimated cost of these tests would be \$900,000.

The authors recommend an initial funding increment of \$100,000 to study the Teletrans medium-speed conveyor system, a secondary distribution system for major activity centers. It was further recommended that \$300,000 be programmed for basic studies to design and test subsystems for reducing passenger time spent in walking and waiting in stations. Immediate research to improve short-haul point-to-point fixed guideway system performance should involve improving designs of loading platforms and pedestrian ways.

NTIS Order #: PB-178-269
PC \$6.00, MF 95¢

Title: "Potential Near-Term Improvements in Urban Transportation"

Author: Day & Zimmerman, Inc.

Date: March, 1968

Project No. NSS-16

Keywords: 1. Modal Split
2. People Movers
3. Environment and Environmental Control
4. Interfaces
5. Parking, planning
6. Right-of-Way
7. Management, operations and techniques
8. Rail, automatic control
9. Rail, stations and terminals

Abstract: The report examines potential urban transportation improvements which have immediate applicability. The use of state-of-the-art technology to solve specific urban transportation problems is discussed. The authors also developed criteria for evaluating priorities in the overall New Systems Study; they conclude that projects should be: (1) operational on land for the purpose of carrying people, (2) able to meet certain standards (ie. economic feasibility and growth potential), and (3) at a point of development where a practical breakthrough within three years is predictable.

The analysis is divided among ten functional categories. These include: (1) a summary of recommendations, (2) transportation and urban life, (3) pedestrians, (4) vehicles and component subsystems, (5) rights-of-way, (6) interfaces, (7) operations, (8) administration, (9) special problem areas, and (10) appended data. The summary of recommendations provides a complete list of the projects and their levels of priority. Under the other subject headings, specific projects, operations, and devices are examined. The latter includes such innovations as pedestrianways, the inertial energy system bus, exhaust fume inhibitors, air-conditioning and environmental control devices, rights-of-way, bus shelters, parking systems, automatic train routing and control, vehicular cleaning devices, short-term management techniques, programmed instruction and training aids, problems of transportation for special urban groups, and jurisdictional restraints. The appendix gives sources of information regarding new systems of urban transportation.

NTIS Order #: PB-178-278
PC \$6.00, MF 95¢

Title: "Feasibility of Federal Assistance for Urban Mass Transportation Operating Costs"

Author: U.S. Department of Transportation, Urban Mass Transportation Administration

Date: November, 1971

Project No. UMTA-UPP-72-1

Keywords: 1. Financing Mass Transportation 4. Government, urban
 2. Government, Federal 5. Government, intergovernmental relations
 3. Government, state 6. Management, operations and techniques

Abstract: The report is a comprehensive feasibility study of Federal assistance for urban mass transportation operating costs. The research was conducted pursuant to Section 9 of the Urban Mass Transportation Assistance Act of 1970 which otherwise prohibits grants of operating subsidies. The purpose of this report was to: (1) determine the financial condition of urban transit systems nationally; (2) review current assistance programs; (3) analyze alternative Federal program options; and (4) synthesize appropriate policy recommendations, including proposed amendments to the Act.

The critical financial state of urban transportation is examined in detail with reference to deficits, transit revenues, and operating expenses. These data reveal substantial cost increases which are exacerbated by the continual erosion of patronage and revenues. The authors also discuss several limitations of the available data which qualify their generalizations.

Five trends in urban development and public policy that have affected transit operations are analyzed in depth. These include: (1) competition with the private automobile, (2) extreme peaking effects in transit demand, (3) public acquisition of transit systems, (4) public regulation of transit operations, and (5) the need for transportation policy coordination. The authors conclude that only a multi-faceted approach can be effective in solving these complex problems. Further, they emphasize the need for improved cooperation and coordination among various public and private institutions. The report also examines existing financial assistance programs for urban mass transportation at all levels of government. Specific state and local subsidy programs are reviewed in detail.

Major issues in the development of alternative Federal assistance options involve defining basic objectives and overcoming the inherent problems of government intervention. At least two such problems include the preservation of incentives for maintaining efficient service and the effective surveillance and control of subsidy allocations by program administrators. Several potential forms of government assistance are analyzed. These include: (1) deficit subsidies; (2) input subsidies [ie. subsidies based on absolute costs of operation]; (3) output subsidies [ie. subsidies based on services provided, passengers carried, or other similar criteria]; (4) modifications of the present Capital Assistance Program; and (4) Revenue Sharing.

The report also discusses briefly a number of potential service and policy innovations to improve mass transit in its present form. Appended material includes examples of innovative transit service demonstrations, a legislative history, specific examples of state and local operating subsidy programs, and guidelines for a Federal subsidy program proposed by the National League of Cities/U.S. Conference of Mayors.

The authors conclude that there is insufficient data available presently to support a definitive solution to the financial crisis or to accurately gauge long-range effects. Consequently the report recommends that: (1) Congress enact proposed legislation for unconditional revenue sharing with state and local governments, and (2) continued study and evaluation of service and policy innovations be maintained by the U.S. Department of Transportation.

NTIS Order #: PB-208-540
PC \$5.45, MF 95¢

Title: "A Mall for Westwood Village: A Study"
Author: University of California at Los Angeles, School of Architecture
and Urban Planning
Date: Winter Quarter, 1971 Proj. #: URT-4

Keywords: 1. Suburbs, business districts 4. Traffic, flow
2. Highway, types 5. Trip Generation
3. Traffic, control 6. Urban Development, planning

Abstract: The purpose of this report is to examine the viability of the concept of a mall for Westwood Village, California. During the four decades of its existence, Westwood Village has preserved a separate identity more effectively than almost any other sub-community of the Los Angeles metropolis. The area is known for its excellent shopping opportunities and pleasant environment, and was one of the first Los Angeles suburbs to host branches of central business district-type retail establishments.

The mall designs hypothesized for this study are of the no-traffic linear-mall and superblock-mall types. Linear-mall is defined as a number of blocks on the principal thoroughfare that are closed to traffic, that are repaved extensively, and upon which a variety of improvements are installed (benches, fountains, statuary, monuments, historical markers, playground equipment, tables and chairs to serve adjoining restaurants, trees, shrubs, and grassy areas). When the linear-mall concept is expanded so that a compact shopping precinct is created out of several adjacent city blocks, the result is termed a superblock-mall..

Three sites were considered for the Mall: (1) Westwood Blvd, (2) Broxton Avenue from just south of the alleyway between Leconte and Weyburn to the corner of Kinross, and (3) a configuration which combined the Broxton and Westwood sites with a few other streets of the core of Westwood Village.

The authors have concluded that the third location is less desirable than either the Westwood or Broxton sites. They have also concluded that no mall is feasible unless a new traffic connector is established between the San Diego Freeway and the northwestern corner of Westwood Village. The worsened traffic conditions which a mall would precipitate would both inconvenience actual users of the Village and discourage potential users or former users, unless the connector is established.

NTIS Order #: PB-203-896
PC \$3.00, MF 95¢

Title: "Freeway and Highway Traffic Noise: An Information Base for Urban Development Decisions"

Author: Samuel R. Lane (University of California at Los Angeles, School of Architecture and Urban Planning)

Date: August, 1971

Proj. #: URT-4

Keywords: 1. Noise and Noise Control 4. Land Use
 2. Urban Development, planning 5. Demography
 3. Highway, planning

Abstract: The report is a comprehensive analysis of traffic noise and its effects on areas surrounding urban highways and freeways. The purpose of the report was to synthesize from existing data an information base regarding noise generation which would be applicable to future urban planning. The author notes in his introductory text that urban noise levels have dramatically increased, especially in proximity to high-speed freeways. A comprehensive assessment of noise impact is therefore essential both to the location of transportation facilities and to land use development in the surrounding area. The Los Angeles urban area was a selected case study.

The report begins with a demographic profile of the study area, including traffic volumes and residential density in proximity to certain freeways. Noise measurements were recorded for both automobiles and trucks and are outlined in detail. In addition, the report documents general surface street noise levels, background noise in communities, and the effect of noise reduction in buildings. Comparative data from the United Kingdom are provided to illustrate the effectiveness of comprehensive noise-reduction programs. On the basis of these data, the author identified "zones of intrusion" surrounding urban freeways where noise levels were excessively high. He notes particularly that the zones did not follow regular patterns, and that high noise levels were recorded at unexpected distances from the highway structures.

The report also contains a subjective rating of traffic noise derived by comparing the noise production of different environments. A regression equation was developed to measure "dissatisfaction" of urban dwellers as a function of traffic noise. The author concludes that a distinct correlation appears between the two variables. Based upon these data, the author also developed "quietness criteria" with which to define unacceptable noise levels in different situations [eg. homes, offices, factories, etc.].

The overall effects of prolonged noise generation in proximity to residential areas are discussed with reference to public health and urban economics. The author notes that traffic noise may create both physical and psychological disturbances when persons are subjected to frequencies above a certain threshold of tolerance measured in decibels. The author also examines economic impacts of traffic noise and concludes that property values may be seriously affected by noise levels.

The report concludes that future urban planning must emphasize greater consideration of noise effects. The author does not advance any specific recommendations, but rather provides an information base with which such planning decisions can be made.

NTIS Order #: PB-204-434
PC \$3.00, MF 95¢

Title: "Remote Sensing: With Special Reference to Urban and Regional Transportation Management"

Authors: Frank G. Mittelbach and Michael I. Schneider (University of California at Los Angeles)

Date: August, 1971 Proj. #: URT-4

Keywords: 1. Sensors 4. Land Use
2. Management, planning and analysis 5. Vehicle, monitoring
3. Measuring and Measurements 6. Traffic, analysis

Abstract: The report is a comprehensive overview of remote sensing and its potential utility in a variety of modern applications, including urban transportation planning. Remote sensing connotes the detection, surveillance, and evaluation of objects and activities without direct contact. The concept derives from the physical properties of energy transmission. Different types of matter transmit energy at specific frequencies on the electromagnetic spectrum; remote sensing employs this principle to permit the monitoring of a distant phenomenon based upon its distinct energy discharge.

The report describes remote sensing devices with reference to the different frequency ranges in which they operate. The equipment may be of two types: (1) active sensors which "illuminate" the target area by transmitting radiation of a particular wavelength and sampling its reflection by the target; or (2) passive sensors which only sample the radiation emitted by specific sources.

The authors note that previous applications of the concept have been in the area of national defense. However, continuing programs of research and development have demonstrated the potential utility of remote sensing to such domestic areas as forestry and agriculture, oceanography and water resources conservation, and geography and land use study. The report contains several practical examples of sensing applications. Infrared wavelength detection, for instance, may be used to measure thermal variations in a selected target area; this permits tracking of effluent discharges in water or air and surveillance of forest fires. Other studies have employed remote sensing to measure general residential variables simultaneously to determine housing quality in a given area.

A major problem in most contemporary applications of remote sensing occurs at the data collection-data reduction interface. While most urban uses of the concept rely upon some form of aerial photography, analysis of the data has generally required visual interpretation by non-automated means. The authors note that attempts to digitize such information have incurred prohibitive cost-effectiveness ratios.

The report also cites some potential applications in the area of transportation planning and management. Remote sensing can, for example, plot traffic flows or define land use interfaces within a complex urban system. The most promising applications are for inventorying such observable data as transportation facilities, travel behavior, traffic movement, and land use. The authors note that remote sensing may be used to assist directly in transportation decision-making, to generate random data for a planning information base, or as an educational device.

NTIS Order #: PB-204-436
PC \$3.00, MF 95¢

Title: "Advanced Urban Transportation Systems: Proceedings of the Carnegie-Mellon Conference on Advanced Urban Transportation Systems"

Author: Carnegie-Mellon University, Transportation Research Institute

Date: May 25-27, 1970

Project No. URT-5

Keywords: 1. Urban Development, planning
2. Financing Mass Transportation
3. Demand-Responsive Systems,
Dial-A-Ride
4. Guideways
5. Dual Mode Systems
6. Intercity Transportation
7. Social Benefits and Costs

Abstract: The purpose of the conference was to summarize the progress of research and development into advanced urban transportation systems (AUTS), to appraise the present status of new systems for urban movement, and to take a long-range look at the primary elements in the development of improved transportation in urban areas. Emphasis was placed on basic issues including the technological, economic, political, and social factors which will influence the implementation of AUTS.

This volume contains the papers presented at the conferences which focused on four major areas: (1) an overview of the developments in AUTS, (2) the fundamental technological and economic problems of AUTS, (3) research areas of high potential, and (4) implementation problems and acceptance prospects for AUTS. Papers in the first general area concern Dial-A-Bus, rapid fixed-guideway transit systems, dual-mode systems, and major activity center distribution systems. The technological and economic problems of AUTS were covered in papers dealing with an overview of AUTS, evaluation methods, automation performance requirements, and door-to-door intercity travel. A historical perspective in transit system development is provided; research areas of high potential covered in papers are: the Federal point of view, the demand for transportation (concepts and methods), and the impact of communities on urban transportation.

Within the general area of implementation problems and acceptance prospects for AUTS, papers discuss political impediments to the adoption of AUTS, labor's response to innovation in the rapid transit industry, and economic innovations for urban survival.

NTIS Order #: PB-199-175
PC \$3.00, MF 95¢

Title: "Impact on Transit Ridership and Revenue of Reduced Fares for the Elderly"

Authors: Ervin S. Roszner and Lester A. Hoel (Carnegie Mellon University, Transportation Research Institute)

Date: July, 1971

Proj. #: URT-5

Keywords: 1. Fare, reductions
2. Fare, passes
3. Elderly
4. Ridership, volume
5. Surveys
6. Benefit-Cost Analysis

Abstract: The report examines a demonstration of reduced transit fares for elderly passengers to estimate their impact on ridership and revenue. The project was undertaken in Pittsburgh during 1970; fares for elderly persons holding special identification cards were cut by 15¢ for off-peak and weekend rides. The report notes that the demonstration was extremely well-received; nearly 60% of all eligible customers (numbering almost 79,000 persons) registered to participate in the reduced fare experiment.

The report documents all relevant aspects of the project with reference to background and survey methodology. Results are outlined for overall ridership (before and after), peak-hour, off-peak, and projected ridership. Expected ridership prior to implementation of reduced fares was a monthly 5.73 round trips per passholder. Average ridership under the plan, however, rose to nearly seven round trips per month. In addition, the authors found that off-peak ridership rose substantially at the expense of demand during peak-hours. More than 1.1 million new trips were estimated to have been generated by the fare reduction.

Net revenue losses to the transit system were approximately \$628,900. The authors calculate that the diversion of peak-hour ridership (when transit productivity is highest) and revenue lost on the volume of base demand offset gains from the otherwise higher number of trips.

A framework for benefit-cost analysis of the reduced fare demonstration is outlined briefly. The authors note particularly that substantial intangible savings may have been generated which are not reflected by computations of net farebox losses. Reproductions of the survey instrument and relevant computer printouts are appended.

NTIS Order #: PB-204-432
PC \$3.00, MF 95¢

Title: "Tube Vehicle Systems: Aerodynamic Characteristics"

Authors: S. William Gouse, Jr. and Ezzat I. Wali (Carnegie Mellon University, Transportation Research Institute)

Date: October, 1971

Proj. #: URT-5

Keywords:	1. Tubes and Tube Vehicles	5. Measuring and Measurements
	2. Aerodynamics	6. Speed and Speed Control
	3. Quantitative Analysis	7. Vehicle, design
	4. Drag	8. Fluids and Fluid Mechanics

Abstract: The report examines aerodynamic characteristics of cylindrical vehicles moving coaxially through solid-wall tubes of finite length. The authors note that tube vehicle systems have received considerable recent attention as innovative modes of high speed ground transport. The tube enclosure affords unique advantages of vehicle protection, noise suppression, and all-weather operation. The presence of tube walls, however, alters aerodynamic flow behavior from what would otherwise occur in a free environment. The fluid dynamic process will affect the drag forces acting on vehicles and therefore substantially influence selection of propulsion equipment.

The purpose of the report was to explore the dependence of drag forces on the velocity of approach ratio, defined as the ratio between the relative velocity of induced fluid pushed ahead of a moving vehicle to the absolute velocity of the vehicle. The study of aerodynamic properties required development of several unique empirical instruments to supplement the knowledge of classical fluid mechanics. Previous studies of flow around a confined body were performed in wind and water tunnels where fluid is in motion relative to a stationary body. Analysis of tube vehicle dynamics focuses upon motion relative to both the body and the enclosure.

Research methodology combined theoretical analysis and performance studies of a scale model. Results of a detailed literature review conducted prior to the theoretical formulation are outlined. The theoretical analysis was divided among four regions of the dynamic tube environment: (1) far flow regions [ie. both ahead and behind the vehicle]; (2) entry zone [ie. the vehicle-fluid interface]; (3) transfer passage; and (4) wake zone. The authors employed various empirical techniques to estimate the probable relationship between drag forces and velocity of the vehicle within specified parameters.

Experimental testing with a scale model was performed to determine whether theoretical results could be replicated. Development of the model and research methodology are outlined in detail. In all, models of six different weights were tested under simulated tube flow conditions for each of nine model designs, making a total of 54 individual experiments. The weight variations were employed to achieve different relative velocities with which to compare aerodynamic drag effects on dynamic tube vehicles. Appended material includes complete model specifications and a computer print-out of the experimental data.

The authors conclude that several important velocity-drag relationships were demonstrated by the study. All relevant equations and data are provided in detail. In addition, the report recommends additional study of vehicle dynamics in tubes containing other media and at higher speeds. A comprehensive understanding of drag and velocity effects will serve to aid the development of specific fluid dynamic criteria for the design of tube-vehicle systems.

NTIS Order #: PB-204-933
PC \$3.00, MF 95¢

Title: "A Methodology for Developing Security Design Criteria for Subways"
Author: Oscar L. Harris, Jr. (Carnegie Mellon University, Transportation Research Institute)
Date: October, 1971 Proj. #: URT-5

Keywords: 1. Crime and Crime Prevention 4. Communications
2. Rail, stations and terminals 5. Lights and Lighting
3. Rail, rolling stock 6. Surveys

Abstract: The report outlines a methodology for developing security design criteria for subway stations and trains. The author notes in his introductory text that incidents of passenger harrassment and vandalism have increased dramatically, and that a systematic procedure for crime control in designing subway hardware and software is therefore warranted. The report focuses on both physical (eg. lighting, construction materials, station design, and communications) and non-physical (eg. passenger volume and flow) factors to develop comprehensive recommendations for subway crime prevention.

The report contains 31 specific design modifications for stations and trains to potentially eliminate common aspects of the subway environment which abet crime and inhibit its prevention. In addition, the author delineates 16 types of crime and harrassment ranging from such misdemeanors as loitering or disorderly conduct to rape and homicide. Each is defined within the context of an urban public transit system.

Based on these data, the author notes six physical factors which delimit the probability of crime and harrassment in subways. These include: (1) space and location; (2) distance and access to open space; (3) visibility; (4) scale; (5) mastery, control, and ownership of property; and (6) conditions of the surrounding urban environment. These factors combined to yield 23 separate data inputs to a systematic methodology for preventing crime by controlling physical design factors in subways and stations. In addition, the author developed 15 non-physical data inputs to his schema which reflect relevant questions about specific incidents. The latter are important in reconstructing behavioral processes and the attitudinal climate in which crime control methods would be implemented. The report examines each of the data inputs at length along with citations from original case material.

Subsequent phases of the methodology are outlined in detail. Having noted the open-ended inventory of crimes and environmental factors, a second stage of the proposed method employs comprehensive surveying procedures to analyze the interrelationships among these variables. Three surveys are recommended to collect relevant data concerning actual incidents of crime and harrassment, characteristics of subway stations, and physical and non-physical conditions aboard trains. Detailed survey instruments and questionnaires are reproduced in the report.

A final phase includes empirical methods for correlating survey data to determine which factors are most prevalent during the occurrence of different criminal activities. The equations derived for analysis of these data would yield optimal recommendations for subway design by suggesting the relationship between physical and non-physical variables and subway crimes. The report does not attempt to explore social factors in the overall urban system, but rather, seeks to develop a schema with which to fashion anti-crime subway designs.

NTIS Order #: PB-204-953
PC \$3.00, MF 95¢

Title: "Behavioral Approaches to Modal Demand Modeling"

Author: Michael J. Demetsky (Carnegie-Mellon University, Transportation Research Institute)

Date: May, 1972

Project No. URT-5

Keywords: 1. Modal Split
2. Quantitative Analysis
3. Ridership

Abstract: The purpose of this research was to formulate and test the significance of a series of areawide behavioral modal demand models. The study attempted to resolve a number of basic questions in the modeling of urban transportation phenomena. These questions involve selecting explanatory variables and mathematical formulae, setting requisite levels of transport sensitivity, and exploring potential applications to study the impact of new systems technology. Basically, the report sought to provide a means of using attitudinal information in conjunction with travel survey data for forecasting.

Areawide travel decisions were viewed by considering individual behavior at the household level. A framework of the individual activity cycle out of which travel decisions arise was formulated to give a theoretical basis for modal split models. Two mathematical techniques, which take on dichotomous dependent variables -- the linear regression model and the probit analysis model -- were applied to estimate models. A series of test cases was designed to indicate the effects of increasing the models' transport sensitivity. Transportation system characteristics were uniquely included in the final models through the introduction of the concept of a modal preference function which takes into account user perceptions of modal characteristics.

The author emphasizes advantages of the probit model for modal split analysis, particularly with reference to its increased sensitivity as a reflection of perceived modal attributes. An example of the application of the behavioral model for forecasting modal split is provided. Lastly, a method of employing the preference model for estimating the effects of improved transit service is presented. Overall, the author concludes that the research demonstrated the utility of these behavioral approaches to modal split modeling.

NTIS Order #: PB-210-882
PC \$3.00, MF 95¢

Title: "Socioeconomic Factors Underlying Public Transit Use in the Journey to Work -- Occasional Paper #1"

Author: Mark J. Kasoff (Syracuse University, Urban Transportation Institute)

Date: June, 1970

Proj. #: URT-7

Keywords: 1. Modal Split
2. Quantitative Analysis
3. Trip Generation
4. Employment
5. Race
6. Private Transportation, automobile
7. Inner City
8. Demography

Abstract: The report summarizes an attempt to generate an empirical model for the evaluation of primary socio-economic determinants of modal choice for work trips in medium-sized cities. The author employed a special empirical methodology which permitted his analysis to utilize readily available census data rather than costly survey material. The subsequent analytical model was demonstrated to be generally reliable for estimating the modal split in medium-sized cities not included in the research sample, but less so for large urban areas, indicating important qualitative differences between cities of different populations.

The model employed one dependent variable (the relative use of public transportation) and seven independent variables which are generally accepted to be determinants of individual transit usage. These variables included: (1) race, (2) automobile ownership, (3) marital status, (4) family income, (5) percentage of females employed in the total labor force, (6) family size, and (7) population and employment density. Data obtained from census tracts were subjected to a variety of empirical computations to determine the effect of each on the independent variable and the relative strength of interactions among them.

The author concludes that results of his analysis confirmed the basic assumption of earlier work trip findings that increased automobile ownership is the most important factor contributing to the decline of transit use in the United States. The latter accounted for as much as 75% of the variance in transit ridership. The analyses of family income were also demonstrated to have a controlling influence on modal split since increasing values of the variable helped to account for greater automobile ownership and movement to suburban areas not served by public transportation.

Some comparisons between the relative effects of different variables in large versus medium sized cities were also yielded. The author suggests, for example, that high parking fees and traffic congestion in the larger urban areas may be disincentives to automobile use even when ownership levels are high. A second example concerned the variable for race which behaved as expected in all cities and suggested a proportional increase in transit ridership as the non-white population increased. The author notes, however, that the variable was less useful as a predictive tool in the smaller cities where the non-white population was not concentrated in a densely inhabited inner city core. Other variables did not yield significant correlations.

The author concludes with an overall evaluation of his analytical tool and recommends changes in the model and data collection procedures for future research.

NTIS Order #: PB-197-575
PC \$3.00, MF 95¢

Title: "Urban Transportation Policy: Fact or Fiction? Occasional Paper #2"

Author: Herman Mertins, Jr. and David R. Miller (Syracuse University, Urban Transportation Institute)

Date: June, 1970

Project No. URT-7

Keywords: 1. Government, Federal
2. Government, intergovernmental relations
3. Highway, planning
4. Highway, financing
5. Financing Mass Transportation

Abstract: The report is a summary of national transportation policies and Federal administrative practices through 1969. The purpose of this research was to examine "inherent paradoxes" in Federal transportation policy and to identify major themes in the legislation. The authors conclude that the United States lacks a definitive, integrated, long-range transportation policy.

The report begins with a detailed review of Federal highway legislation, particularly emphasizing its impact on the formation and implementation of urban transportation policy. The second section is a review and appraisal of legislation that specifically pertains to urban mass transportation, especially the Urban Mass Transportation Act of 1964. Funding provisions of highway and non-highway programs are emphasized as indications of an unwritten Federal policy.

The effects of Federal organizational changes are discussed as they relate to the scope and impact of urban transportation policy. This analysis focuses particular attention upon the creation of the Department of Transportation (DOT) and the Urban Mass Transportation Administration. Coordination of programs and policies between the Department of Housing and Urban Development and DOT, and between different DOT agencies, is also studied.

A final section discusses and evaluates the interaction between Federal policy and urban transportation problems. The need for "balanced" transportation policies is emphasized.

NTIS Order #: PB-197-580
PC \$3.00, MF 95¢

Title: "Residential Segregation, Metropolitan Decentralization and the Journey to Work" Occasional Paper #3.

Author: David Greytak (Syracuse University, Urban Transportation Institute)

Date: July, 1970

Proj. #: URT-7 (69)

Keywords: 1. Employment
2. Trip Generation
3. Race
4. Center City
5. Inner City
6. Survey

Abstract: The purpose of this paper was to present the results of a study conducted to determine the interrelationship between housing segregation, the decentralization of urban areas, and work trips.

Previously gathered interview data from the Survey Research Center of the University of Michigan provided the statistical basis for the study. The data were collected in personal interviews of a sample of 748 families, which was representative of all families in the United States, exclusive of the New York - Northeastern New Jersey area.

As the spatial redistribution of many types of trade and manufacturing activities has favored peripheral areas, the central cities have become more and more specialized in functions which require chiefly professional, technical, and clerical workers--a trained, skilled and literate work force. But it is the skilled and literate segment of the population which increasingly has selected suburban residences. At the same time, nonwhites whose residential location to a large extent has been confined to central city ghettos find themselves increasingly isolated from the jobs and occupations found in many types of manufacturing, trade, and household service occupations, which are moving further away.

The author concluded that it is primarily in the nations' biggest cities that residential segregation and employment decentralization confer substantial and higher work trip costs on nonwhite heads of household. Evidence continues to indicate that employment-access advantages continue to accrue primarily to whites rather than to nonwhites. If housing segregation had not existed, employment dispersal would have provided strong incentives for many nonwhites to relocate in suburban residences near their new workplace locations. At the same time, in the absence of encroaching racial ghettos some centrally employed whites now residing in the suburbs would be located within the central cities.

NTIS Order #: PB-196-904
PC \$3.00, MF 95¢

Title: "The Urban Frontier -- Occasional Paper #4"

Authors: Robert Barden and John H. Thompson (Syracuse University, Urban Transportation Institute)

Date: 1971

Proj. #: URT-7

Keywords:	1. Land Use	5. Center City
	2. Land Acquisition	6. Housing
	3. Urban Development, planning	7. Demography
	4. Quantitative Analysis	

Abstract: The report examines areas on the outer fringe of urban systems, called the urban frontier. The author dismisses generally accepted hypotheses about the pattern of urban land values which suggest a direct correlation between valuation and distance from the central business district. The conventional graph of this relationship thus represents a downward curve with some intermittent rises to reflect secondary commercial or industrial nuclei. The report attempts to refute this relationship by demonstrating the existence of an urban frontier where land valuation drops off substantially. Thus land values are shown to correlate with distance from the core city only up to specific radial distances beyond which the regular pattern does not obtain. The report attempts to develop a methodology for locating the urban frontier and for estimating the relative inputs by which it is defined.

The author traces background investigations of the concept dating back to 1962 when it was introduced as a means of defining the extremities of urban sprawl. A hypothetical case study is provided for illustration. Here it is shown that extending outward from the core city, the valuation of residential real estate reaches a threshold at the urban frontier. Although the hypothetical frontier in this case is only about one mile wide, the author notes decreases in land values beyond it of as much as \$1500/acre. In addition, the case reveals a close correlation between the frontier boundary and arterial access routes to the central city. Transportation is therefore judged to be a primary determinant of the shape of urban development. Similarly, land values reflect proximity to access routes, and the dramatic drop-off in such values beyond the urban frontier may be caused by termination of the routes or a threshold in acceptable travel times to the city core.

The report contains further examples of the model applied to Syracuse, Utica-Rome, Albany-Schenectady-Troy, Rochester, Buffalo, and Binghamton, New York. Analysis of results obtained from these applications indicated three factors of particular importance in favoring and hindering urban growth. These included: (1) highway accessibility, (2) pre-growth population distribution, and (3) physical environment characteristics. Using regression equations to measure the relative influence of these factors on growth patterns in the examples, the author demonstrated the accuracy of his urban frontier concept and the primacy of transportation as an indicator.

NTIS Order #: PB-204-056
PC \$3.00, MF 95¢

Title: "Measuring Accessibility -- Progress Report I" Occasional Paper #5.
Author: Thomas J. Milbanks (Syracuse University, Urban Transportation Institute)
Date: October, 1970 Proj. #: URT-7

Keywords: 1. Access, planning and control 4. Modal Split
2. Quantitative Analysis 5. Measuring and Measurements
3. Trip Generation 6. Maps and Mapping

Abstract: The report is the first in a series designed to examine "accessibility" and its effects on land use and human behavior. Accessibility is defined as an attribute of relative spatial location which implies the ease with which any specific point can be reached. The author notes that earlier studies have failed to demonstrate an empirical correlation between accessibility and its presumed effects. This has resulted in two conflicting hypotheses, that (1) accessibility is not of functional importance in a systems context; or (2) accessibility is extremely important, but has not been measured accurately. The purpose of the report is to survey the existing methodology and to test the second hypothesis.

A major premise of the report is that existing measurements of accessibility stress time and distance relationships at the expense of more detailed attention to human behavioral processes. The series of reports will ultimately attempt to generate new models with which the impact of accessibility can be measured and predicted within given urban situations.

The author begins with a conceptual discussion which amplifies his thesis that behavioral factors qualify the influence of spatial distance in measuring accessibility. He notes that several factors may affect the least-effort evaluation of distance (ie. human preference among locations is proportional to the effort necessary to travel to them) in the human mind. These include: (1) time costs; (2) nonlinear transformations of distance in human judgements [ie. so that the inhibiting effect of a distance increment may vary with the initial distance to which the increment is appended]; and (3) distortions of space by "mental maps" which reflect value judgements imposed by the individual.

The report then reviews several current indices of accessibility, which are divided between two broad categories. The first employs adaptations or components of mass-gravity interaction models; the second employs network interaction models to accommodate a factor to represent "intervening opportunities" (ie. influences on accessibility which exist between the origin and destination). Derivation of each empirical model and relevant equations are provided.

The author concludes that the basic schema for calculating accessibility values is sufficiently straightforward, but that three problems arise in the preparation of data inputs. These include: (1) The importance of accessibility in travel decisions has not been demonstrated with sufficient empirical evidence; (2) Accessibility measurement has not provided for a systematic integration of modal preference data or for the hypothesis that modal choice may eclipse distance factors in travel planning; and (3) Various kinds of origins and destinations (eg. homes, shopping, offices, recreation) differ in nature and thus reflect equally different access-value patterns. The author recommends increased attention to accessibility as an element of public policy discussions and general geographic theory.

NTIS Order #: PB-204-880
PC \$3.00, MF 95¢

Title: "Developing and Testing of a Behavioral Modal Split Model"
Author: W. Bruce Allen, et. al. (University of Pennsylvania, Transportation Studies Center)
Date: June, 1971 Proj. #: URT-8

Keywords: 1. Modal Split 4. Quantitative Analysis
2. Ridership, volume 5. Qualitative Analysis
3. Market Research 6. Surveys

Abstract. The report summarizes development and testing of a behavioral modal split model designed to estimate the demand for alternative modes of urban transportation. The authors focus principally on methods of forecasting modal split in morning work trips to the central business district of a major metropolitan area. Existing models were developed primarily by engineers and other technicians using empirical time and cost data to synthesize projections of demand for different modes. Three problems, however, were found to limit the application of such models. These problems include: (1) their neglect of behavioral factors which influence modal choice; (2) the imprecise sequencing of modal split studies with other facets of transportation planning which may affect their output; and (3) their emphasis on permanent, structural conclusions rather than estimates tailored to varying conditions.

The authors attempted to develop a non-empirical, behavioral method for studying modal split. The new model emphasizes: (1) perceived attributes of different modes which affect their attractiveness to potential users; (2) experience and habit as principal determinates of modal choice; and (3) possible long-range aspects of automobile ownership in which factors other than commuting time and cost may influence usage.

The report provides a general background and literature survey of psychological, sociological, market, and economic factors relevant to transit ridership. The development of sophisticated techniques for behavioral analysis in the social sciences is discussed in detail. The authors conclude that transit patronage represents a consumer decision not unlike that exercised in the purchase of common household products. The procedure for developing a behavioral modal split model is also described in detail. The authors employed linear regression analysis to test the relative influence of different factors on the selection of one or another alternative transportation mode by individuals. A variety of possible models are analyzed in the report, complete with all relevant data and equations.

The consequent behavioral model employs survey data to match public preferences with alternate transit systems. The model uses several variables which permit the classification of individual respondents into the groups most likely to select certain modes under given conditions. These variables include: personal characteristics (eg. age, income, sex, and race); points of origin and destination; the relative importance of cost, safety, and convenience factors to the individual; and his perceptions of time, costs, and convenience associated with each alternative mode. The perceived attributes of different systems were emphasized as crucial factors not treated by previous models. To this extent, the observed distribution of ridership among different modes may indicate that the public harbors misperceptions about the quality of transportation offered by such modes.

Appended material includes a complete bibliography of behavioral and modal split literature and a detailed survey of earlier modal split studies.

NTIS Order #: PB-204-941
PC \$3.00, MF 95¢

Title: "Analysis of Peak Period Passenger Flows on the Lindenwold Rapid Transit Line"
Authors: David E. Boyce & B.V.A. Murthy (Univ. of Penn., Transportation Studies Cr.)
Date: June 30, 1971 Proj. #: URT-8

Keywords: 1. Rail 4. Headways
2. Parking, capacity and demand 5. Ridership, volume
3. Survey

Abstract: In February, 1969, the Delaware River Port Authority initiated a new high-speed rail transit service connecting Lindenwold, New Jersey, and Center City, Philadelphia. Patronage of the High-Speed Line at the time of its opening was approximately 14,850 persons per day, and had reached 32,000 persons per day by April 1, 1970. At that time traffic conditions had become extremely critical at some stations because the available number of parking spaces could not meet the demand. In response to this situation, the Delaware River Port Authority, during the summer of 1970, expanded its parking facilities from 5,896 to 8,244 spaces, an increase of 40 percent. In order to analyze the effect of these improvements, before-and-after surveys were conducted. This paper reports the results of the analysis of one set of data obtained from these surveys--the flow of transit passengers through the stations. These results not only document the before-and-after flows, but also provide useful information for scheduling of service and estimation of station volumes in comparable situations.

Most of the daily round trips on the transit line originate in the low density areas served by six stations from Lindenwold to Ferry Avenue. Special emphasis is given to the analysis of traffic conditions at these six stations. The study is limited to the morning peak period, approximately 6:30 A.M. to 10:00 A.M., and to westbound trains only. On April 1, 1970, entrance and exit gate meters were read at the New Jersey stations at fifteen minute intervals beginning with the 6:30 westbound train from Lindenwold. This particular train is designated as the No. 1 train, and the subsequent westbound trains were referred to as the No. 2, No. 3, and No. 4 trains. For every other station, the fifteen minute intervals begin with the No. 1 train's departure from the particular station. On November 18, 1970, a slightly modified procedure was followed in making the gate readings. Entrance and exit gate meters were read at the scheduled departure time of each train from each station, thus permitting a more detailed train-wise analysis. Three basic assumptions were made in processing gate readings: (1) For the six suburban stations, all the entering passengers were assumed to be westbound trip makers. (2) Whenever needed, a uniform arrival rate of passengers was assumed between two successive meter readings. (3) For some of the trains, the total number of passengers boarded differs from the total number of passengers alighted. In such cases, unaccounted for passengers, are allotted to 9-10 Locust Street Stations for which no data were collected.

A comparison of the number of passengers arriving at the six suburban stations in the 2 1/4 hour peak period of April 1, 1970, and November 18, 1970, revealed that the maximum absolute increase was at Lindenwold station and the maximum percentage increase was at Collingswood station. Comparison of transit usage distribution for April 1, 1970, and November 18, 1970, showed an overall increase in passengers at all stations for November 18. Except for Ashland station, each station also showed a higher peak. Passenger arrival rate curves for 15 minute intervals for the six suburban stations were plotted to compare the positions of the peak for different stations. The peak arrivals of the stations fell in order of distance from Philadelphia, except for Westmont. Lindenwold, the farthest station, had the earliest peak; Ashland station had the next earliest peak, and so on.

NTIS Order #: PB-203-780
PC \$3.00, MF 95¢

405

Index No. 4-00-8.3

Title: "An Investigation of the Car-Following Model Using Continuous System Model Program (CSMP) Techniques"

Authors: Lawrence Eisenberg and Edward Kaplan (University of Pennsylvania, Transportation Studies Center)

Date: June, 1971

Proj. #: URT-8

Keywords:	1. Traffic, analysis	4. Quantitative Analysis
	2. Computer, applications	5. Private Transportation, automobile
	3. Computer, programming	6. Private Transportation, driver

Abstract: The report explores quantitative methods for modeling car-following dynamics. The authors discuss general aspects of traffic theory in which analysts attempt to predict the behavior of grouped road vehicles according to empirical relationships among such distinct variables as vehicle performance specifications, roadway surface conditions, and driver characteristics. By developing mathematical equations to correlate these variables, analysts can simulate "real life" traffic dynamics without having to conduct field experimentation. The concept of traffic simulation is described in detail along with the various stages of model building.

The report also discusses feedback control as an essential factor in a traffic simulation model. Feedback control assumes that drivers in a dynamic situation constantly re-adjust their operation of a vehicle according to their perception of various conditions around them. It is therefore necessary to include in a car-following model some measure of driver reaction to the dynamic highway environment. The authors explore relevant feedback control equations at length.

The basis of the car-following simulation is a special computer program developed to integrate the various hypothetical conditions described above. The authors outline their Continuous System Modeling Program (CSMP) in detail. The report also contains several computer print-outs which reveal the effectiveness of the CSMP in actual operation. The authors conclude that traffic flow may be better understood from the viewpoint of dynamic simulation modeling.

NTIS Order #: PB-204-001
PC \$3.00, MF 95¢

Title: "Transportation Networks as a New Urban Space Partition"

Author: Robert G. LeRicolais and Alexander Messinger (University of Pennsylvania,
Transportation Studies Center)

Date: May 31, 1970

Project No. URT-8

Keywords: 1. Urban Development, planning 4. Access, planning and control
 2. Pedestrians 5. Speed and Speed Control
 3. Traffic, analysis 6. Intersections and Crossings

Abstract: The report studies the application of graph theory to abstract concepts of transportation network configurations. The research stemmed from work performed in the development and evaluation of the Trihex Grid system as a geometric alternative to existing and other proposed urban transportation designs. In essence, the authors attempt to delineate practical alternatives to rectangular street networks in urban areas which they hold to be inefficient. In addition, they attempt to embrace the "overall urban communication problem" which may have been ignored by the previous analysts.

The report proposes a Trihex Grid system for use by regular vehicular traffic. This system appears as a tessellation of regular triangles and hexagons which are further subdivided to permit the separation of pedestrians and vehicles.

Three alternative models were tested to compare the Trihex Grid and conventional orthogonal grid systems as both transportation networks and as urban space partitions. In each case, the grids were superimposed on similar urban configurations and analyzed with a measure of accessibility. The report also examines continuous flow networks with reference to five potential grid systems. All relevant statistical material is included along with a brief summary of proposed future research.

The authors conclude that Trihex Grid systems are superior to orthogonal networks with regard to several basic characteristics. These systems can enable planners to synthesize better solutions for producing more efficient pedestrian and vehicular circulation.

NTIS Order #: PB-203-779
PC \$3.00, MF 95¢

Title; "The Crosstown Controversy: A Case Study"

Author: Thomas A. Reiner, et. al. (University of Pennsylvania, Transportation Studies Center)

Date: September, 1970

Proj. #: URT-8

Keywords:	1. Government, urban	5. Public Relations
	2. Urban Development, planning	6. Highway, planning
	3. Urban Development, renewal	7. Social Benefits and Costs
	4. Community Response	8. Benefit-Cost Analysis
		9. Qualitative Analysis

Abstract: The report is a detailed case study of the controversy surrounding a proposed crosstown highway in Philadelphia. The author focuses on urban decision-making processes and institutions to conclude that highway planning does not effectively resolve conflicts of interest among participants. A chronological history of the crosstown controversy is outlined in detail. The author notes that the basic issues have remained unresolved for nearly half a century and that no ultimate solution is likely to be generated by existing institutions. The background material covers all relevant aspects of the policy and planning process with particular emphasis on institutional roles.

An analysis of the conflict revealed that a principal obstacle to effective highway planning occurred with the introduction of normative values and competition among political interest groups. The author notes particularly that value judgements were made throughout discussions that were ostensibly technical in nature. In addition, the report notes that planning authority was often fragmented so as to produce competition among public agencies and interest group representatives. Benefit-cost analyses were shown to either ignore relevant community and social values or to overemphasize subjective judgements by the analysts themselves. The report also notes a general lack of authority to choose between technical and social aspects of the proposed construction. In general, the policy planning process was characterized by fragmentation, political pressures, and a general failure to handle the mix of subjective and objective argumentation.

Several specific recommendations are advanced to redress the current disorganization of participants in urban highway planning processes. The key proposal would be provision of Community Technical Services (CTS) to improve and increase community participation in transportation decision-making. The author notes particularly that the CTS would replace public hearings which he feels are poor vehicles for community self-expression. Related administrative and budgetary adaptations are also discussed. A second basic recommendation would institute provision for judicial review in resolving similar highway controversies. The author notes that existing procedures lack any role for disinterested third-parties, and that the courts could serve well in such a capacity. The purpose of employing judicial review would be to filter out policy-makers' normative values.

A final section of the report examines evaluative techniques. The author notes that these presently place substantial emphasis on cost-benefit analyses which may ignore essential community values. The report proposes a multi-client group evaluation model in which a table would be constructed to compare the costs and benefits of a proposal as they are likely to be perceived by different interest groups. In this manner, the aggregate factors in policy making can be analyzed in combination, rather than in increments at different stages of the planning process. Appended material documents specific alternative crosstown highway proposals for the Philadelphia metropolitan area.

NTIS Order #: PB-203-899
PC \$3.00, MF 95¢

Title: "Value of Speed in Public Transit Services"

Authors: Vukan R. Vuchic, et. al. (University of Penn., Transp. Studies Center)

Date: November, 1970

Proj. #: URT-8

Keywords: 1. Benefit-Cost Analysis 5. Qualitative Analysis
 2. Speed and Speed Control 6. Fares
 3. Time Costs 7. Right-of-Way
 4. Quantitative Analysis 8. Ridership

Abstract: The purpose of this report is to define--quantitatively or qualitatively--all the relationships between speed, costs, and benefits of a transit service. The definition of these relationships would make it possible to develop a systematic method of evaluating the transit speed of any mode of urban public transportation.

The research is based on a model of a transit service. The model incorporates all relevant time segments involved in service, and the sensitivity of travel speed to these individual elements is explored. Emphasis is given to the travel time within the transit system; other travel times, such as access to and departure from the line are mentioned, but are not analyzed deeply. The model of the transit line is based on the assumption that the vehicle stands in a station for an interval of time, the length of which depends on the number of passengers and several other factors. The vehicle then accelerates to its maximum cruising speed which it then maintains until it has to start deceleration for the next station. This process is repeated for each interstation spacing. It is also assumed that the vehicles have a certain terminal time interval at each end of the line. The basic model has been modified to represent two different kinds of transit systems. One system is assumed to operate on a private right-of-way, with vehicle movement being fully deterministic. It is also assumed that the vehicles will accelerate to the maximum technical speed permitted by the length of the interstation spacing. The second system represents the operation of transit vehicles in mixed traffic. The expression for travel time of this system includes an additional interval of time representing delays caused by interference from other traffic. Maximum cruising speed of these vehicles is in most cases lower than the maximum technical speed of the vehicles.

A conceptual analysis of the consequence speed change was developed. If it is supposed that an investment is made to increase transit speed through such action as reduced stop time at stations, a reduced number of stations, or increased acceleration rates, then such an action would result in a change of operating costs of the system on one side, and in the increased speed of the system on the other side. The increased speed permits either reduction of the number of vehicles required for a given service, or increased frequency of service if the number of vehicles is held constant. Also the increased speed creates a direct benefit to the users of the system by reducing their travel time. It also attracts additional patronage because of the improved level of service. Tracing further the reduced number of vehicles, one can notice that this can result either in direct savings to the operator, or in reduced fares, if the savings are passed over to the users. Reduced fares therefore represent direct user savings, and they also make the service more attractive, thus leading to increased patronage. This increase in patronage may require increased frequency of service, thereby bringing the whole transit system to a more profitable region of operation. The increased frequency of service results in user savings in terms of reduced waiting time and increased convenience; it also results in the attraction of additional patronage. In addition to the general conceptual structuring of the consequence of speed changes, this study has produced the basic computational equations for quantitative estimates of individual events, benefits, and costs. Another extension of this work is an analysis of possible methods for speed increases which draws heavily upon the results of the research reported here. Such a study of methodology is currently under way as a new research project.

Title: "Dual Mode Transportation Systems: Analysis of Demands and Benefits in Urban Areas; and Development of Performance Requirements"

Author: Daniel Brand (Massachusetts of Technology, Urban Systems Laboratory)

Date: June, 1970

Proj. #: URT-9

Keywords:	1. Dual-Mode System	6. Social Benefits and Costs
	2. Demand-Responsive Systems	7. Environment & Environmental Control
	3. Guideways	8. Traffic, peak-hour
	4. Private Transportation, automobiles	9. Benefit-Cost Analysis
	5. Intermodal Competition	10. Trip Generation
		11. Taxonomy

Abstract: The report summarizes an attempt to determine the nature of demand for, and benefits from dual mode guideway systems in urban areas, and to develop performance requirements for such systems. The dual mode concept assumes vehicles operating at high densities under automatic control while on automated guideways. The vehicles would be capable of operation off the guideways, retaining the characteristics of conventional automobiles and buses, namely manual operation on shared rights of way. The report advances dual mode systems as an alternative to urban freeways and private automobile commutation which it argues extract undesirable social costs in terms of space consumption, pollution, safety hazards, and additional direct costs from the poorest groups in society. However, the author maintains that only such innovative systems as dual mode can compete with automobiles by providing the same door-to-door service.

The report analyzes the generic dual mode concept with respect to: (1) prospects for conventional urban transportation modes; (2) the taxonomy of innovative/existing urban transportation services; (3) travel demands for innovative urban transportation systems; and (4) the costs of innovative transportation improvements. The author concludes that only an innovative system capable of providing door-to-door, demand-responsive service can effectively meet existing or projected travel demands, given the need for an alternative to urban expressway construction and automobile use. The dual mode approach is recommended as the system best capable of combining the desired passenger service with automated, fixed guideway linehaul operations.

The report then examines performance requirements for a dual mode guideway system. Three basic performance parameters are discussed in detail, including capacity, guideway spacing, and speed. The author suggests that subsequent research projects should develop cost-benefit models. Overall, the report is concerned only with the dual mode concept, as opposed to an examination of any specific system.

NTIS Order #: PB-196-371
PC \$3.00, MF 95¢

Title: "Project IS: Improved Scheduling, An Investigation of the Possibility of Reinstating Owl Service on Certain Lines of the Massachusetts Bay Transportation Authority (Final Report)"

Author: Marc Roddin (Massachusetts Institute of Technology, Urban Systems Laboratory)

Date: May, 1970

Project No. URT-9

Keywords: 1. Schedules and Scheduling 5. Ridership
 2. Surveys 6. Rail, commuter
 3. Social Benefits and Costs 7. Benefit-Cost Analysis
 4. Employment 8. Off-Peak Traffic

Abstract: The report investigates the possibility of reinstating "owl service" (ie. service between midnight and 6:00 A.M.) on certain rapid transit and streetcar lines operated by the Massachusetts Bay Transportation Authority in Boston. The study includes background information and calculation of demand potential through passenger questionnaires and interviews. Researchers found substantial interest in resumption of owl service among workers who could not otherwise use public transportation for commuting to overtime or night-shift duties.

The author further concludes that the benefits of owl service would extend beyond the immediate user group, "because many current non-users would have a feeling of security if they knew that service was available to them should they need to take it." A network of seven transit lines was calculated to have potential for profitable owl service, and the report notes that general social benefits of the operation would exceed costs. The author details his cost-benefit procedures with which the overall benefits were computed.

NTIS Order #: PB-196-408
PC \$3.00, MF 95¢

Title: "Urban Transportation Decision-Making: 1 -- Political Processes of Urban Freeway Controversies"

Author: Kenneth R. Geiser, Jr. (Massachusetts Institute of Technology, Urban Systems Laboratory)

Date: June, 1970

Project No. URT-9

Keywords: 1. Community Response
2. Highway, financing
3. Urban Development, planning
4. Government, state
5. Government, urban
6. Relocation
7. Public Relations
8. Advertising and Promotion
9. Surveys
10. Highway, planning

Abstract: The report examines the history and nature of controversies which have surrounded the construction of urban freeways in various American cities. A decisional (case study) approach was employed to identify salient elements of freeway controversies and to analyze such disputes as a national phenomenon.

Background information covers the history and context of freeway controversies with reference to highway planning and Federal funding legislation. Specific controversies are examined in three cities: (1) Seattle, (2) Baltimore, and (3) Boston. Based upon these case studies, the author develops a model of urban highway controversies applicable to urban areas generally.

The nature of protest activity is examined with reference to the different actors who participate in freeway controversies. These include organized protest groups, professional advocates, the mass media, and the community at large. Various protest tactics and activities are described. The nature and role of highway planning in freeway controversies is also discussed.

The government response to freeway controversies represents a key element in the decisional model. This component is examined with reference to evolutionary phenomena, public transportation planning, state highway development agencies, design teams, the role of elected officials, and government responses generally. The report concludes with the author's interpretations of freeway controversies. Specifically, he discusses technical planning aspects of political decision-making, the responsiveness of government to protest activities, and the meaning of social controversies and social health.

NTIS Order #: PB-198-060
PC \$6.00, MF 95¢

Title: "Urban Transportation Decision Making -- 3: San Francisco, a Case Study"
Author: Frank C. Colcord, Jr. (Massachusetts Institute of Technology, Urban Systems Laboratory)
Date: April, 1971 Proj. #: URT-9

Keywords: 1. Government, Federal 6. Highway, planning
2. Government, state 7. Urban Development, planning
3. Government, urban 8. Bay Area Rapid Transit
4. Government, intergovernmental relations 9. Community Response
5. Rail, systems planning and design 10. Public Relations
11. Environment and Environmental Control

Abstract: The report is a case study of transportation decision-making structures and processes in the San Francisco Bay Area. The author notes in his introductory text that political, economic, and social variations among major American cities warrants a case approach in studying different responses to "the transportation problem". The report therefore examines the roles of various groups and institutions in fashioning specific transportation programs for San Francisco.

The report begins with an overview of the transit environment, noting such relevant data as the nature and distribution of economic activity, socio-economic characteristics of the population, and observed transportation habits. The author notes that while construction of the Bay Area Rapid Transit (BART) system demonstrates public concern for urban transportation, two fundamental issues remain unresolved. These include: (1) satisfying demand for movement to outlying industrial areas; and (2) effectively controlling automobiles.

Politics and government are examined at both the state and local level to delineate the institutional structure in which transportation decision-making occurs. The report also explores intergovernmental relations, business leadership at the community level, and minority-group representation in San Francisco. Regional transportation planning is also discussed in detail.

The political aspect of Bay Area transportation is examined separately between highway and public transit decisions. State and local highway planning agencies are identified; the author notes particularly the evolving role of state government in resolving Bay Area transportation problems. Two specific highway controversies are analyzed to reveal political cross-pressures which enter the planning process. These include a dispute over location of a major freeway and the diversion of highway toll revenues by a special district government to assist in the development of a rapid rail system.

Public transportation decision-making is examined with reference to state and local government agencies, private carriers, regional transit authorities, and interest group representation. The overall policy planning process as distinct from political decision-making is also discussed. Four cases are analyzed to reveal the nature of public transportation controversies. These include environmental issues, site selection, and financial aspects of the BART system and proposed extensions of the existing San Francisco Municipal Railway.

The author concludes that transportation decision-making in San Francisco is marked by the innovative and responsive leadership of mature institutions, working within an efficient seven-phase planning structure.

NTIS Order #: PB-204-954
PC \$3.00, MF 95¢

Title: "Urban Transportation Decision-Making -- 2: Houston, A Case Study"

Author: Frank C. Colcord, Jr. (Massachusetts Institute of Technology, Urban Systems Laboratory)

Date: November, 1970

Project No. URT-9

Keywords: 1. Urban Development, planning
2. Highway, planning
3. Government, state
4. Government, urban
5. Government, intergovernmental relations
6. Inner City
7. Race
8. Topography
9. Community Response
10. Private Transportation, automobile
11. Traffic, congestion

Abstract: The report is one in a series focusing upon case studies of urban transportation decision-making. The author notes in his introductory text that while elements of a "national urban transportation crisis" are evident in most cities, a wide variety of social, economic, political, and physical variables affects the nature of transportation decisions in specific urban areas. The report examines such decisions (and the processes and institutions with which they are fashioned) in Houston, Texas.

A detailed description of the study area is provided with reference to historical background, geography and topography, and socio-economic characteristics. The author concludes that Houston is developing into a full-scale regional metropolis, with heavy emphasis on white collar businesses such as finance, insurance, and real estate. Of particular importance to the development of regional transportation systems has been the area's general lack of physical barriers to growth and the easy availability of individual mobility. These factors have contributed to Houston's relatively low population density and land use intensity.

Politics and government are also examined with emphasis on both state and local institutions. The report focuses upon provisions of the state constitution, roles of the governor and legislature, political traditions in Houston and Harris County, forms of government in the region, and efforts toward urban reform government. The analysis of transportation decision-making gives particular attention to conflict-management in highway construction and location decisions which have been so controversial in other urban areas.

The author concludes that the Houston experience has been relatively unique in its avoidance of "freeway revolts" and the general furor which has attended transportation decision-making in other cities. Six factors may explain this situation: (1) Because the Texas Highway Commission's master plan for the Houston region was initially developed by the City Planning Department, there have been few intergovernmental disputes. (2) A sizeable amount of freeway construction was completed during the early 1960's and thus preceded the area's rapid growth; development patterns have since followed the existing lines of transportation access, and the consequent need for displacing established neighborhoods for highway sites has been minimized. (3) Routes cutting through the inner city affected either run-down commercial areas where residents were eager to relocate or through largely Negro neighborhoods where organized resistance to construction was not mobilized. (4) Because the area boasts an extremely high degree of automobile ownership, opposition to improved highway transportation systems has been limited. (5) The existing bus system provides reasonably adequate service for transit captives in the inner city. (6) The City has relatively little downtown traffic congestion due to an effective spacing of major arterial streets and the availability of adequate parking facilities.

NTIS Order #: PB-206-224
PC \$3.00, MF 95¢

Title: "Research Project Summaries"
Authors: Consortium of Universities, Urban Transportation Center
Date: August, 1970 Project #: URT-11

Keywords: 1. Universities 2. Bibliographies

Abstract: An Urban Mass Transportation Administration grant to the Consortium of Universities made it possible to award fellowships to graduate students seeking a Master's or Doctor's degree. The Urban Transportation Center was established to administer the grant and included the University of Maryland as well as the five Consortium Universities: The American University, The Catholic University of America, Georgetown University, George Washington University, and Howard University.

The essential requirement of a fellowship from the Center was a completed research project on a phase of urban transportation applicable to the Washington Metropolitan Area or the Washington-Baltimore Corridor.

Participating in the first program of the Urban Transportation Center were fellows seeking degrees in sixteen different disciplines. Summaries of the Spring Semester, 1970 Urban Transportation Center's twenty-eight research projects are reproduced in this report, with biographical information on each fellow.

NTIS Order #: PB-194-107
PC \$3.00, MF 95¢

Index No. 4-00-11.1

415

Title: "WMA Transit Company"

Author: Beach W. Aten and Gary F. Bulmash (Consortium of Universities, Urban Transportation Center)

Date: Spring, 1970

Proj. #: URT-11

Keywords:	1. Bus, cost	4. Advertising and Promotion
	2. Market Research	5. Routes and Routing
	3. Financing Mass Transportation, requirements	6. Fares, cost determination
		7. Ridership

Abstract: The purpose of this report is to describe WMA Transit, and attempt to analyze its various functional areas, along with the regulatory commission that governs them.

WMA Transit Company is a small, privately-owned bus line serving the eastern half of the Washington metropolitan area with routes fanning out from downtown to Greenbelt and Bowie, Maryland, on the north, and Oxon Hill and Andrews Air Force Base on the south. Single routes extend to Chesapeake Bay in Calvert County and to Indian Head in Charles County, but the others are all contained in Prince Georges County and in the District of Columbia.

WMA Transit has some unique operational problems. The average passenger's ride during the peak periods is considerably longer than on D. C. Transit (DCT). They have a passenger turnover per run of only slightly better than one, compared to DCT's four times per run. The average revenue received per passenger for WMA in regular service was 37.68¢, while DCT received only 26.79¢ per passenger. WMA's passengers ride longer distances and pay higher fares (due to the zoned fare structure), but DCT receives much more revenue per run because of their higher turnover. In 1965 and 1966 the route miles operated increased faster than passenger volume.

An examination of the most recent financial statements reveals the system's tenuous financial position. The most striking parts of these statements are the net losses of the last two years and the negative earned surplus (retained earnings) for the year ended December 31, 1969. In 1968, debt financing exceeded equity financing by nine times -- a high multiple. For 1969, the relative value skyrocketed to thirty times. The huge increase in debt financing in the last few years was due primarily to WMA's purchase of forty new buses during this period. The huge debt obligations incurred because of the equipment purchased raised both the debt financing and interest expense, as well as depreciation charges. Unfortunately revenue did not increase as swiftly and extensively as management may have anticipated.

The authors recommend the development of a viable marketing program emphasizing the areas of market research, product planning, pricing, and promotion. This action is necessary in order that WMA can begin to extricate itself from the cost-revenue squeeze it is now enmeshed in. Effort must be made to design attractive transit packages tailored to the needs, aspirations, and perceptions of the various market segments so that lost patronage can be regained and present ridership retained.

NTIS Order #: PB-194-093
PC \$3.00, MF 95¢

Title: "Dulles International Airport Access"

Author: Robert G. Baxter (Consortium of Universities, Urban Transportation Center)

Date: Spring, 1970

Proj. #: URT-11

Keywords: 1. Airport, access
2. Airport, planning and operations
3. Modal Split
4. Trip Generation
5. Private Transportation, automobile
6. Traffic, peak-hour
7. Parking, capacity and demand
8. Parking, facilities
9. Parking, planning
10. Access, planning and control
11. Freight Movement

Abstract: The report is a detailed study of highway access to the Dulles International Airport, emphasizing the relationship between daily vehicular volumes on existing access roads and the number of daily departing passengers. The basic objective of the report is to provide long-range planning data and to recommend methods for handling traffic volumes in the access corridor.

Data were obtained in a variety of relevant categories dealing with traffic distribution, modal split, passenger distribution, and vehicle occupancy on the Airport access road. The author notes particularly the significance of his data which were gathered through actual traffic counts. Earlier studies relied on sample projections or analysis of existing statistics. The material is presented in four basic areas: (1) traffic distribution at the Airport; (2) parking lot utilization; (3) time and modal distribution (broken down among bus, limousine, and taxi passenger distribution); and (4) occupancy per vehicle (broken down between public and private transportation).

Two basic conclusions were yielded by the analysis. First, the report notes that public transportation to the Airport is under-utilized and that existing service is inefficient. Second, the report notes that during peak travel periods, as much as 15% of the access road volume represents commuter traffic. Although the author concludes that this additional demand adds an insignificant volume to the under-utilized access road, he notes that projected increases in Airport operations, employment, and adjacent land development will severely tax the road's capacity in the future.

Several recommendations are also advanced. First, the author suggests separating purely commercial and airport employee traffic from the volume generated by air travelers and commuters. The report does not attempt to separate Airport traffic and commuter traffic on the access road. The importance of distinguishing between commercial and public traffic is based on the author's projection of cargo handling and industrial growth in the Dulles Airport vicinity and consequent demands on the highway facility for goods movement.

Second, the report notes the increasing volume of international flights terminating at Dulles, and recommends a separation of these from domestic operations with each served by distinct physical and access facilities. Third, the author suggests construction of "satellite" parking areas for long-term users connected by rapid transit to the Dulles terminals.

Finally, as a long-range recommendation, the report discusses the feasibility of handling passenger service through suburban terminals which could connect enplaning travelers with the Airport by means of existing or expanded public transportation. The report gives particular attention to projected Metro routes to Dulles and to pilot projects with passenger services operated at suburban terminals.

NTIS Order #: PB-194-094
PC \$3.00, MF 95¢

Index No. 4-00-11.3

Title: "Methods of Improving Transportation Facilities for Inner-City Dwellers"

Author: Ernest Cooper (Consortium of Universities, Urban Transportation Center)

Date: Spring Semester 1970

Proj. #: URT-11

Keywords: 1. Inner-City 4. Race
2. Trip Generation 5. Urban Development, planning
3. Poverty 6. Communications

Abstract: The purpose of this paper is to consider methods of improving transportation facilities for inner-city dwellers within the scope of a metropolitan area. Washington, D. C.; Nashville, Tennessee; New York, New York, and other major urban areas were used as case studies. The major thrust was to investigate methods to provide optimal transportation services to inner-city residents and equality of access to employment, recreational, and other urban opportunities.

The basic trip purposes for inner-city dwellers are for: jobs, personal shopping, schools, personal business, and social-recreational activities. In a New York study, it was found that 41 percent of all trips were reported "to home", 19 percent "to work", 13 percent "to shop" and 3 percent to "social-recreation". A trend is evident here. Most of the trips made by low-income residents either begin or end at home. This characteristic implies a restriction in the diversity of travel and daily activities of inner-city residents. The trips made for social-recreational reasons also reflect this trend. Only about 3 percent of the total daily travel was made for this reason. The rate for average households in suburban areas is 10 to 12 percent.

A research project done by the Survey Research Center of the University of Michigan indicated that in households with incomes of less than \$1,000, 76% are non-car owners; 69% of all families in the \$1000 to \$1999 bracket owned no car, as compared with 16% in the over \$10,000 class. Less than half of all black households with heads over 65 years old did not own automobiles. There are many individuals who are isolated from jobs because they cannot afford a car. They are confronted with inadequate public transit to jobs which have been shifted to the suburbs. In many cases, racial and economic segregation prevent them from moving out close to the job. There is also a class of low-income families who are in extraordinarily heavy financial trouble because they are trying to buy a car for transportation to and from work, when financially they cannot afford it. The lack of a car not only isolates the poor of the inner city from their jobs, but also from social, recreational, and health facilities.

The solution of inner-city, city, intercity, and intercoastal transportation has its root in integrating transportation development with urban development. The improvement of transportation services for inner-city residents should be analyzed using short and long term objectives. Inner-city residents must be able to circulate as well as other urban dwellers. The evidence points out that the present mass transit system is not achieving this mobility for inner-city dwellers. Bus transit is geared for trips to the central business district, and evidence indicates that this need is decreasing. The government should actively participate in assisting inner-city dwellers to achieve mobility. The subsidization of private personal vehicles should not be overlooked. This should be done entirely by the Federal government, by the Federal government and the automobile industry, or by the automobile industry. Long range objectives can only be realized through sound urban planning. Until "software" elements have a higher priority in formulating plans, a balanced transportation system will not be realized. Communication offers great hope in decreasing trip necessity. Open-housing and lower priced housing units in the suburbs of the city would also decrease the need for reverse commuting.

NTIS Order #: PB-194-095
PC \$3.00, MF 95¢

Index No. 4-00-11.4

Title: "Specialized Trip Distribution Study: Metropolitan Recreation"
Author: Theordore Ehrlich (Consortium of Universities, Urban Transportation Center)
Date: Spring, 1970 Proj. #: URT-11.
Keywords: 1. Recreational Facilities 3. Quantitative Analysis
2. Trip Generation 4. Demography

Abstract: The report attempts to develop a demand model for estimating trip distribution at recreational facilities in an urban situation. The Washington, D. C., metropolitan area was the selected example. The author notes that a literature survey indicated the need for improved recreation planning. The purpose of the report was therefore to construct a model which would estimate demand for recreational facilities as a function of transportation access, demography, and travel distance.

The author notes in his introduction that demand for recreational facilities transcends jurisdictional boundaries and thus requires planning along different lines than are commonly used for providing other social services. He also suggests that empirical analysis of non-residential, non-work trip generators have received insufficient attention in previous transportation studies.

Survey procedures and data collection methods are described in detail. The author employed demographic and land use information prepared in 1968 by the regional Council of Governments. In addition, a license plate survey was conducted at major recreational areas throughout the Washington metropolitan district to determine generally the residence of park users. The license plates were then correlated with records at the Department of Motor Vehicle Registration to determine the specific residential origin or persons who had driven to the recreation areas. On the basis of these data, the author developed a preliminary model which computed overall park visitation as a function of population in the user's residential areas and travel time.

The author then attempted to employ a gravity model to compute trips from a residential area to a recreational area. The gravity model concept assumes a proportional relationship between the attractiveness of these areas with reference to spatial separation. The author concludes that his method proved successful in replicating most of the observed demand and recommends future study to verify his model and extend it to other applications.

NTIS Order #: PB-194-096
PC \$3.00, MF 95¢

Title: "Methodological and Parametric Foundations for Urban Transport Technology Evaluation"
Author: Philip A. Graham (Consortium of Universities, Urban Transportation Center)
Date: Spring, 1970 Project #:URT-11

Keywords: 1. Research Operations 5. Qualitative Analysis
2. Quality Control 6. Quantitative Analysis
3. Social Benefits and Costs 7. Benefit-Cost Analysis
4. Structural Analysis

Abstract: The exploration of techniques to help urban transportation planners systematically compare technologically disparate transport systems was the concern of the project reported herein. Though particular attention was focused on urban passenger travel, the author points out that the techniques which evolved are applicable in principle to all fields of transportation.

The "methodological" portion of the project was concerned with the preliminary development of quantified procedures for evaluating candidate modes; the viewpoint taken was that such procedures should operate in auxiliary roles, enhancing the value of the planner's judgement by clarifying the options open to him (rather than leading directly, with planner inputs, to system selection). The methodology which resulted from adopting this philosophy, the author notes, may be tailored not only to highly complex and sophisticated analyses in which vast amounts of concrete data are available, but also to situations where either a simplified approach is preferable or where information is incomplete or unreliable.

The "parametric" portion of the project sought to discover which characteristics must be considered in the evaluation of candidate transport technologies (This subject area is quite distinct from that of methodology, in that methodology concerns the manner in which characteristics are to be used once they are identified.). Two opposite approaches were utilized for parameter identification: (1) a "synthetic" approach, in which literature survey information is cross-correlated and grouped to build up a broad picture of the parameters of interest; and (2) an "analytic" approach, in which the starting point is a broad view of the transport problem. Logical methods are applied to break down this broad view into specific areas for consideration.

The latter approach, the author states, appears to be much more powerful, providing a clear framework within which the relevance of individual characteristics of the overall problem can be seen; however, he notes that the former approach remains important, particularly since it includes information obtained by empirical means. Therefore, the author recommends that the two methods be used in tandem to provide a more complete picture of transport parameters of interest.

NTIS Order #: PB-194-097
PC \$3.00, MF 95¢

Title: "The Politics of Innovation in Urban Mass Transportation Policymaking:
The New Systems Example"

Author: David G. Lawrence (Consortium of Universities, Urban Transportation
Center)

Date: Spring, 1970

Proj. #: URT-11

Keywords: 1. Government, Federal
2. Government, Intergovernmental Relations
3. Urban Development, Planning

Abstract: The report represents one chapter from the author's doctoral dissertation in political science which dealt with the Federal policy-making process. The New Systems Study conducted by the Department of Housing and Urban Development (HUD) in 1966 was a selected case study. The report follows this innovative research program in urban transportation hardware through three stages of initiation, approval, and implementation.

The initiation stage involves formulation of policy goals and the impetus to action from various sources. The report examines briefly the history of relevant Federal legislation prior to 1966, and focuses on amendments passed by the 89th Congress to the 1964 Urban Mass Transportation Act. Within the initial stage, three sources of impetus are examined: the actor, the executive, and "expertise". The author identifies one Congressman as the primary actor who had become dissatisfied with innovative research outputs generated by the 1964 Act. The other impetus sources were analyzed primarily as they affected concerns of the primary actor. Conferences with technological research organizations convinced the Congressman of the need for a large-scale, industry-wide new systems study; concern for urban needs articulated in Presidential messages and passive response by executive policy administrators gave further impetus to the project.

The approval stage follows the subsequent legislative proposals through both houses of Congress, emphasizing policy inputs resulting both from committee proceedings and floor debate. The author is particularly concerned with the legislative process as it relates to innovative, technological and research-oriented programming. No substantial opposition to the study of new systems was encountered, although the relative merits of existing research versus the special study were scrutinized.

The report gives major attention to implementation of the project by HUD as a case study of executive action based on legislative policy articulation. The report suggests that the agency concerned was ill-prepared to undertake a project of the New Systems magnitude and that subsequently, implementation procedures were developed largely without bureaucratic restraints. The research undertaken is summarized in detail with numerous citations from the original material.

The author concludes that the New Systems project was a policy failure. Specifically he notes that the Federal system was largely unresponsive to outputs of the research, and that few of its recommendations were followed-up with implementation. The report emphasizes these results as indications of broader policy-making problems inherent in the Federal process due to incrementalism, inertia, and lack of follow-through.

NTIS Order #: PB-194-098
PC \$3.00, MF 95¢

Title; "The Evolution of Metro"
Author: William J. Murin (Consortium of Universities, Urban Transportation Center)
Date: Spring, 1970 Proj. #: URT-11

Keywords: 1. Rail, systems planning and design
2. Government, Federal
3. Government, urban
4. Financing Mass Transportation
5. Construction, cost
6. Survey
7. Land Use
8. Government, intergovernmental relations

Abstract: The purpose of this report is to trace the evolution of the METRO rail rapid transit system. In 1952 the National Capital Planning Act directed the National Capital Planning Commission (NCPA) and the National Capital Regional Planning Council (NCRPC) to prepare comprehensive plans for land use, major thoroughfares, and the movement of people and goods in the region. The transportation portion of the mandate was realized in the Second Supplemental Appropriations Act of 1955 which provided funds for the NCPA and NCRPC to jointly conduct a survey of the present and future mass transportation needs of the National Capital region and to report their findings and recommendations to the President.

While the studies continued, the Congress in 1957 created a Joint Committee on Washington Metropolitan Problems (JCWMP), under the chairmanship of Senator Alan Bible. This committee conducted a comprehensive survey of metropolitan problems apart from the transportation activities of the NCPA and NCRPC, investigating such areas as water supply, sewage disposal, land use, economic development, intergovernmental relations, and transportation problems. In January, 1959, three more reports, which ultimately were to form the core of the entire program, were issued by the Joint Steering Committee.

In July of 1959, the long awaited Transportation Plan for the National Capital Region made its public appearance. The recommended system consisted of 33 miles of rail rapid transit, 66 miles of express bus routes, and parking facilities for the rail and bus routes, all totaling \$564 million. The freeway portion of the plan called for 329 miles of new freeways and expressways costing \$1.8 billion, and \$119 million worth of downtown parking facilities. Total cost of the entire system was estimated at almost \$2.5 billion. The National Capital Transportation Agency (NCTA) was created and directed by Congress to evaluate the 1959 plan; to consider alternatives to the plan that might be less costly to the city; to coordinate transportation planning in the region; and to report its findings to the President no later than November 1, 1962.

As 1969 came, construction of the rail system had still not yet begun. In January, the President submitted his 1970 budget to Congress including \$22.9 million for the District's contribution to construction costs. In June, the Senate approved \$18.7 million for construction in a 1969 supplemental appropriations bill. This item was subsequently deleted in conference. The reason was the District's failure to comply with the 1968 Highway Act by building the Three Sister's Bridge and the North Central Freeway. William Natcher, Chairman of the House Subcommittee on Appropriations for the District of Columbia, refused to allow subway construction funds to be released until the freeway system got underway beyond recall. In September, in a surprise move, Mr. Natcher announced that he was releasing almost \$121 million in METRO funds. In May, the Secretary of Transportation and Commissioner of the District of Columbia submitted to Congress legislation authorizing Federal participation in a 97 mile regional system. In December, President Nixon signed the legislation into law and official groundbreaking ceremonies were held on the same day.

NTIS Order #: PB-194-100
PC \$3.00, MF 95¢

Title: "Impact of Transportation Noise on Urban Residential Property Values with Special Reference to Aircraft Noise"

Author: Inja K. Paik (Consortium of Universities, Urban Transportation Center)

Date: Spring, 1970

Proj. #: URT-11

Keywords: 1. Noise and Noise Control
2. Housing

3. Land Use
4. Quantitative Analysis

Abstract: The report attempts to validate empirically certain hypotheses concerning the effect of noise (particularly aircraft noise) on residential property values. The author notes that some earlier observations pointed up less than normal property value increases in noise-affected areas. Other studies suggested that land use patterns in areas adjacent to prime noise-generators (eg. airports) were shifting from residential to industrial/commercial, thus raising the assessed value of property. The author attempts to examine two basic hypotheses using data from the vicinity of John F. Kennedy International Airport in New York. These hypotheses are: (1) that noise-affected areas do exhibit unnatural rates of property value increase, and (2) that noise creates different relative effects on property values in commercial and residential neighborhoods

Although the author has confined his analysis to aircraft noise and its effects on an area immediately adjacent to a major airport, he advances an analytical model relevant to other forms of transportation. The model employs several independent variables which influence property values. These include such factors as area population, number of residential properties, number of single-family dwellings, number of substandard dwellings, median number of rooms per unit, nonwhite population, persons per room, and median income. These variables were assessed in random samples collected both within and outside specific high-noise corridors identified by earlier reports. The author then attempted to employ linear regression analysis to his data to develop a model for evaluating the effect of each variable on the average property value. The effect of noise was integrated into the equation by including an additional variable to measure the "noise exposure forecast" levels (documented in a previous study) present.

In his conclusion, the author notes that the model performed effectively, once it had been corrected to control "multicollinearity" (ie. the combined influence of two or more variables). Results tended to support the two initial hypotheses, demonstrating that noise did exert a negative influence on property values and that these effects were more pronounced in residential areas.

NTIS Order #: PB-194-101
PC \$3.00, MF 95¢

Title: "D. C. Transportation Controversies, Values and Integration of Communities"

Author: Francis R. Parente (Consortium of Universities, Urban Transportation Center)

Date: Undated

Proj. #: URT-11

Keywords: 1. Highway, planning 4. Routes and Routing
2. Community Response 5. Government, Federal
3. Government, urban

Abstract: During 1969 three controversies developed over the location of freeways in the District of Columbia area. The controversies concerned the building of a bridge over the Potomac River at Georgetown, the location of the north leg of the North Central Freeway in the Negro ghetto of D. C., and the proposed building of a freeway through a park in Silver Spring, Maryland. All three of these proposed constructions were part of an integrated highway system for the District area. All of them generated intense opposition on the part of local residents and others most directly affected when it was time to begin construction.

Students of political and social relations are only recently beginning to examine the applicability of integration theory to the local metropolitan community level of analysis. Political integration implies a relationship of community among people within the same political entity. They are held together by mutual ties of one kind or another which give the group a feeling of identity and self-awareness. Integration, therefore, is based on strong cohesiveness within a social group, and political integration is present when a political government is cohesive. If integration is indeed taking place and the resolve of localized sub-communities to unite in order to maximize their collective strength is hardening, new modes of governmental action may be necessary. This may mean that citizen participation on a systemic or metropolitan level--rather than on a neighborhood or local level--will have to be sought. The demands and ideas of representatives of many groups and multiple geographical areas of the city will have to be considered and accommodated at the same time before integrated efforts for solving metropolitan problems can be undertaken.

The District of Columbia highway controversy concerned the proposed construction of a freeway system having several branches, routes and legs circling around and extending from the mall-downtown-Capitol Hill "heartland" of the city. In the circle are Georgetown on the West, Robert F. Kennedy Stadium on the East, the Mall on the South, and Florida Avenue and U Street on the North. The North Central Freeway extends outward from the circle to Maryland and Interstate 95; the Three Sisters Bridge extends westward from the circle across the Potomac River to Virginia and beyond.

Interest in and opposition to the highway plan built up steadily during the 1960's as the plans for the system began to crystalize and as official reports, studies, governmental inquiries and the clamorings of the District's politically impotent masses surfaced again in the local press. At the instigation of individual taxpayers, landowners and civic organizations, the U. S. District Court of Appeals in February, 1968, issued an injunction, halting the highway program on the grounds that the requirements of the U. S. Code had not been met. In August, 1968, the U. S. Congress enacted the Federal-Aid-Highway Act designed to override the court injunction. Two series of public hearings were held in the District regarding major thoroughfares. This research analyzed these hearings to determine whether integrative issues or elements were present. The results of the evaluation are contained in the report.

NTIS Order #: PB-194-102
PC \$3.00, MF 95¢

Title: "Commuter Transportation Problem, University of Maryland"
Author: Robert E. Prangley (Consortium of Universities, Urban Transportation Center)
Date: Undated Proj. #: URT-11

Keywords: 1. Universities 5. Parking, cost
2. Private Transportation, 6. Parking, facilities
Automobile 7. Parking, planning
3. Bus, commuter 8. Parking, regulations
4. Parking, capacity and demand

Abstract: The report analyzes the demand for commuter facilities and evaluates alternative proposals for providing them on the University of Maryland campus. In his initial overview, the author notes particularly the extremely high proportion of commuter students at the University and the inadequacy of present facilities which consist primarily of limited public bus service and congested parking areas for private automobiles. Three alternative commuter transportation systems are analyzed: (1) extended parking facilities on campus, (2) increased public bus service emphasizing off-peak schedules, and (3) use of peripheral parking areas linked by bus with the immediate campus.

The report begins with an analysis of the commuter profile, based on a sample population of 24,000, aggregated by zip codes. The author notes that locations of commuter residences appeared to be more rigidly defined than expected and that proximity to the University was a major factor in applications. The cost and capacity of existing University parking facilities were analyzed along with the service provided to the campus by local public transportation. Existing peripheral parking facilities were studied to determine whether utilization by students was feasible. The study focused particularly upon available parking space in nearby shopping centers which is under-utilized during the hours of peak commuter demand. The author recommends further study of economic factors inherent in achieving the consent of private owners to use their facilities. A brief calculation of parking demand demonstrated the viability of the latter concept, assuming compliance by owners of the regional shopping centers. The report notes that University scheduling of classes creates a dual peaking effect on parking demand, and that a redistribution of classes could spread out the static demand to minimize parking and shuttle bus requirements. System costs for the peripheral parking-bus link alternative are included, broken down between leased and University-operated bus systems.

The various proposals were also evaluated according to demand as indicated by student surveys. The author concludes that a substantial number of commuters favored the auto-bus solution provided that the service would not unduly extend travel time. The author concludes that the third alternative noted above would be optimal, providing that negotiation for use of the peripheral lots can secure compliance from private owners. The author also recommends strongly the economic regulation of parking facilities, and for immediate rescheduling of classes to distribute peak transportation demands throughout the day. Complete statistical data is appended.

NTIS Order #: PB-194-103
PC \$3.00, MF 95¢

Title: "Commuter Railroad Service in the National Capital Region"
Author: Arthur J. Smith (Consortium of Universities, Urban Transportation Center)
Date: August, 1970 Proj. #: URT-11

Keywords: 1. Rail, commuter 5. Government, urban
2. Rail, rolling stock 6. Center City
3. Rail, systems planning and design 7. Industrial and Labor Relations
4. Government, Federal 8. Ridership, volume
9. Intermodal Competition

Abstract: The report is a comprehensive overview of commuter railroad service in the Washington, D. C., metropolitan area. In his introductory text, the author notes a crisis in other modes of surface transportation which he maintains could be relieved by redevelopment of the commuter railroad. Automobile traffic congestion in the center city and along major arterials is discussed along with the erosion of public bus transit services.

The report examines the experiences of four other cities (Chicago, Boston, Philadelphia, and New York) in which rail is still a principal commuter mode. The author notes that ridership decline has been a common national phenomenon. Based upon the four case studies, he synthesized several basic problems of commuter rail service generally. These include: (1) public preference for the private transportation mode; (2) unbalanced public assistance to transportation programs which emphasize highway construction; (3) decentralization of the metropolitan core; (4) difficulty of adjusting rail services in response to changing patterns of urban growth; (5) peaking of ridership demand which creates uneconomical utilization of equipment and manpower; (6) fare structures which do not adequately reflect costs; (7) unreasonable work rules for union labor which inflate operating costs; (8) deterioration of existing equipment; and (9) insufficient private capital for investment in service improvement programs. These problems are discussed with reference to the four case cities.

The decline of railroad commuter service in the Washington, D. C., area is analyzed in detail; the problems cited above were found to be particularly relevant. The report traces the history of these operations in Washington and notes their steady decline until recent years. At present, fewer than 20 trains continue to serve the Nation's Capital, carrying only approximately 1,100 riders daily. In addition, these few remaining services are threatened by rising fees at Union Station, restrictive labor work rules, terminal location, and aging rolling stock.

An analysis of existing plans for regional rail service notes that during the 1960's, area planning agencies envisioned a combination of regular commuter trains and rapid transit. The report cites documentation from planning studies undertaken by various agencies and the United States Congress through 1968 when the proposed Metro rapid transit system was begun. Under the current planning arrangements, three railroad commuter systems would be coordinated with various segments of Metro. However, the author concludes that management, labor, and financing problems may threaten realization of these plans, and that all railroad commuter service may be abandoned before completion of the rapid transit. In addition, he concludes that a viable rail system is possible and desirable, given sufficient support by government agencies and potential customers.

NTIS Order #: PB-194-104
PC \$3.00, MF 95¢

Title: "A Metro Park-Ride Fare Collection System"
Author: Edward D. Studholme (Consortium of Universities, Urban Transportation Center)
Date: Spring, 1970 Proj. #: URT-11

Keywords: 1. Fares, collection 3. Parking, facilities
2. Parking, Park-and-Ride 4. Parking, cost

Abstract: The purpose of this study is to design and evaluate the "Metro Park-Ride Fare Collection System". The study is divided into three sections: (1) In section II relevant background material is provided explaining Metro's impact, the park-ride system and the automated fare collection system. (2) In section III the Park-Ride Fare Collection System (PRFC) is examined both conceptually and with specific reference to functional design alternatives. (3) In section IV an alternative chosen on the basis of favorable design impressions is subjected to a cost analysis which includes the pricing of necessary hardware, adjustments for peak hour requirements for specific stations, and a comparison with a manual system.

The Adopted Regional System has a total of 97.7 route miles, 37.7 of which are in the District of Columbia, 29.9 in Maryland, and 30.1 in Virginia. Of this, roughly 47 miles will be subway and 51 miles will be surface rails. The 86 stations will provide 44 major distribution points for the District, 22 for Maryland, and 20 for Virginia. Of these, 53 will be subway and 33 will be surface facilities. Under the Regional System, a total of 30,100 spaces will be provided for 68,324 daily patrons who will drive to a station and leave their cars until they return. Cost estimates base the site area requirement of park-ride on a ratio of 350 square feet per car, including space for aisles, but actual measurements of some site plans indicate that this can approach 400 square feet per car when lots have an irregular shape and landscaping is included. Structure parking is economically feasible only when land values exceed \$5 per square foot, and at present only two structures are planned.

Fares are to be paid under a stored value system which employs a magnetically encoded fare card which will be constructed of plastic coated paper and will have a strip of magnetic tape fixed lengthwise on one surface. Various machines will be capable of performing logical functions in response to directives received from these cards as patterns of magnetic marks are converted into electrical impulses and interpreted in the same fashion as most modern electronic computers "read" data stored on tape. For example, upon entering a station a patron will purchase a fare card from a vending machine. This machine will accept up to \$20 in bills and coins and encode the exact amount received on the card as it is issued. In order to gain access to the platform where the trains arrive and depart, the patron must pass through a fare gate. This gate will accept his fare card, remove it from his possession and encode it with the station of entry before returning it as he is admitted. The patron has now passed from the free area to the paid area. Although no value has been deducted from his card, he must now pay to exit from the paid area to the free area at his station of destination.

The author has concluded the PRFC system is not only economically feasible, but in comparison to a manually operated fare collection system, is capable of effecting a substantial reduction in operating costs.

NTIS Order #: PB-194-105
PC \$3.00, MF 95¢

Title; "Parking and Urban Dynamics"
Author: Burnell W. Vincent (Consortium of Universities, Urban Transportation Center)
Date: Spring, 1970 Proj. #: URT-11

Keywords: 1. Parking, facilities 4. Private Transportation, automobiles
2. Parking, planning 5. Parking, cost
3. Urban Development, planning 6. Parking, capacity and demand

Abstract: The purpose of this report is to demonstrate the direct impact that the availability of parking has upon the shape of the urban form and to suggest some approaches to inclusion of these effects in the urban development model. This report lists the advantages and disadvantages of providing or not providing the demanded terminal capacities in various urban situations.

In most microcosmic decisions regarding transportation the automobile is heavily favored. Although it does not offer the most economical or efficient means of linking home to work in the urban situation, it is still the means of individual choice of the great majority of commuters. There are two advantages offered by auto that are not available in other alternatives: independence and convenience. Within the present framework of values it is predetermined that circumstances offering realization of these advantages will be chosen by those portions of the population able to do so. It therefore must be accepted by planners that within this framework automotive accessibility is one of the factors of viability. Availability includes a wide range of factors beyond the simple numbers of parking spaces. Some of the determining factors are: (1) parking rates; (2) amenities, such as weather protection for car and person; (3) safety hazards presented by parking near fast moving traffic; and (4) security. (Dark streets in downtown areas are frequently considered as offering no available parking.) These considerations which determine the availability of parking show the diversity of the task involved in its provision.

Failure of planners to provide available parking in a way which guides development of the urban form in accordance with those characteristics established for the optimal plan will have a far-reaching detrimental impact. Some results of failing to provide availability to meet the demand include: (1) redistribution of various trip destinations to those locations which do provide parking; (2) artificially high transportation costs resulting from decreased availability; (3) extension of commutation times; (4) public inconvenience; and (5) worsening traffic congestion.

It is the role of local planners and policy makers to determine the feasibility of the various transportation options and the costs involved in achieving each option. To the degree that parking availability will affect progress toward the desired goals, it should be so directed. Policies should be established which discourage counterproductive actions, such as a tax for parking in certain areas, or a tax for not providing parking to accompany traffic generators. Wherever it is neither constructive nor detrimental to local goals, all economically feasible efforts at achieving citizen comfort and convenience should be undertaken. The next step is the determination of the direction and degree of the impact of various subordinate policies for achieving these goals.

NTIS Order #: PB-194-106
PC \$3.00, MF 95¢

Title: "The Effect of Age on Urban Travel Behavior (Report #1)"

Author: Norman Ashford and Frank M. Holloway (Florida State University, Transportation Center)

Date: June 30, 1970

Project No. URT-12

Keywords: 1. Age
2. Ridership, profiles
3. Trip Generation
4. Demography
5. Elderly
6. Youth
7. Quantitative Analysis

Abstract: The study was conducted to obtain a quantitative analysis of the effect of a tripmaker's age upon several urban travel parameters. The selected parameters were: (1) percentage of trips made interzonally, (2) percentage of trips made to or from the central business district, (3) car occupancy, (4) percentage of trips made by transit, (5) trip generation rate by purpose, and (6) trip length frequency distribution and mean trip length. For comparative purposes, the effect of age on these aggregate parameters was examined for six cities of varying geographic location and population size. Results of the analyses were obtained by five separate trip purposes (ie. shopping, hospital visits, social visits, commutation, etc.) and three modes.

A further stage of analysis was carried out on the trip records of 900 randomly selected tripmakers in the Milwaukee area. The importance of age on the travel behavior of the individual was analyzed by the construction of regression models relating the above travel parameters to 37 selected personal and zonal socio-economic variables.

The most significant findings indicated that the average trip length remained relatively constant for adults. Elderly people were found to make proportionately fewer intrazonal trips and more trips to the CBD. Transit usage was high for the young and the elderly and reached its minimum value for young adults. Trip generation rates changed considerably with age and purpose. Work and shopping trips increased in importance with age; the work trip, however, declined rapidly in importance when the individual reached retirement age.

The study indicates large variations in travel behavior and travel demand over an individual's life span. Furthermore, these variations were not apparent in aggregated travel demand as traditionally analyzed and projected in urban transportation studies.

NTIS Order #: PB-196-843
PC \$3.00, MF 95¢

Title: "Joint Development: An Economic Input" (Report #2)

Author: David W. Rasmussen (Florida State University, Transportation Center)

Date: June, 1970

Project No. URT-12

Keywords: 1. Joint Development
2. Benefit-Cost Analysis
3. Social Benefits and Costs
4. Urban Development, planning
5. Quantitative Analysis
6. Air Pollution
7. Intermodal Competition
8. Private Transportation
9. Modal Split

Abstract: Joint development projects emphasize the integration of social, physical, and transportation planning. This report attempts to analyze the economic inputs to joint development planning. The author notes that general economic analyses have not sufficiently embraced a systems approach that includes both direct economic and indirect social costs.

In discussing the economist's role in joint development planning, the author emphasizes two basic problems for analysis: (1) effects of the project on the regional economic base, and (2) selection of the dominant transportation mode. The report stresses the systems approach that permits analysts to consider the externalities of urban phenomena. In this sense, mode selection implies specific consequences in terms of mobility, air pollution, and other social factors. The discussion of mode choice for joint development projects focuses upon trade-offs between public and private transportation.

The report concludes with a brief discussion of future directions for joint development and the economist's planning role. The author demonstrates his joint development method as a new dimension to previous approaches to regional and urban planning.

NTIS Order #: PB-197-819
PC \$3.00, MF 95¢

Title: "A Methodology for Incorporating Community Values into Planning Goal Formulation (Report #3)"

Author: James G. Brandon and Merl Coon (Florida State University, Transportation Center)

Date: June, 1970

Project No. URT-12

Keywords: 1. Joint Development
2. Social Benefits and Costs
3. Community Response
4. Ridership
5. Qualitative Analysis
6. Quantitative Analysis
7. Urban Development, planning

Abstract: The report proposes a general research strategy for identifying community goals. The theoretical basis for the paper is the concept of joint development, expanded to include a social-cultural as well as a physical context in the process of goal identification. This expanded process was developed by introducing a three-dimensional approach consisting of functional, ethical, and "meaning" dimensions. Based upon the proposition that the crucial concern of planners for introducing social-cultural data into the goal identification process is a concern for developing planning proposals more palatable to the community itself, the paper argues that developing a research strategy based on the meaning dimension will be most immediately useful.

Consequently, a general strategy is offered, based on symbolic interaction theory and the participant observation method. Participant observation is to precede the use of standard quantitative approaches such as social and attitudinal scaling in an attempt to produce more valid data in the context of its meaning to community members. Finally, the paper introduces a general discussion of relationships among values, attitudes, and responses to technological change. It is concluded that in the introduction of technological change into a community, a conflict model of community is most applicable. Data on values and attitudes may be used to facilitate the introduction of change. Given inherent conflicts in the goal dimensions proposed in this paper, change generally involves political as well as scientific processes.

NTIS Order #: PB-196-579
PC \$3.00, MF 95¢

Title: "Proceedings of the University of Oklahoma Urban Transportation Institute - 1970"

"Selected Topics from the Proceedings of the University of Oklahoma Urban Transportation Institute - 1970"

Author: R. D. Bowman, ed. (University of Oklahoma, Urban Transportation Institute)

Date: August, 1970 Proj. #: URT-15

Keywords: 1. Bus, commuter 7. Modal Split
2. Freight Movement 8. Trip Generation
3. Corridors 9. Demography
4. Private Transportation, 10. Employment
Taxicabs 11. Quantitative Analysis
5. Site Selection 12. Ridership, profiles
6. Highway, planning

Abstract: The "Proceedings" volume is a compilation of eight graduate-level theses prepared at the University of Oklahoma Urban Transportation Institute. In his brief introduction, the program director notes that a basic objective of the Institute was to promote interdisciplinary analysis in urban transportation. The report notes that a particular problem encountered in so-called "team" design techniques for urban transit systems has been the unfamiliarity of social scientists and engineers with each other's frame of reference. The papers in the volume are therefore attempts to integrate social, political, economic, and environmental perspectives with available engineering technology in planning for urban mass transportation.

The eight papers included in the volume are titled:

1. "The Potential of Bus Transit for Commuters of Major Employment Centers"
2. "An Inquiry into the Feasibility of Predicting Demand for Freight Transportation for the Oklahoma City Standard Metropolitan Statistical Area"
3. "Toward A Total Cost Method for Transportation Corridor Location in Urbanized Areas"
4. "Taxicab Use Within a Small Oklahoma Town"
5. "Criteria Used in Determining the Location of an Urban Controlled Access Highway"
6. "An Econometric Model of Work Trip Modal Choice: A Study of the Central Business District of Oklahoma City"
7. "Social Factors Affecting the Use of Public Transportation in Oklahoma City"
8. "Urban Transportation Socioeconomic Variables -- Their Effect on the Extensiveness of Mass Transit Systems in American Cities"

The "Selected Topics" volume reproduces the first three papers listed above.

NTIS Order #: PB-197-918
PC \$3.00, MF 95¢

Index No. 4-00-15.1

Index No. 4-00-15.2

Title: "Planning Urban Transportation Systems: A Model for Generating Socially Desirable Transportation Network Configurations -- Research Report #2"

Author: Hirotaka Koike (University of Washington, Seattle)

Date: 1970

Proj. #: URT-16

Keywords: 1. Social Benefits and Costs 5. Routes and Routing
 2. Qualitative Analysis 6. Ridership, attraction
 3. Employment 7. Quantitative Analysis
 4. Poverty 8. Benefit-Cost Analysis

Abstract: The report summarizes the author's effort to develop a model capable of designing new or improving existing transportation networks in a way that will achieve a given social goal. The goal employed in this analysis is the increase of an index called satisfaction level. The latter is a function of opportunity (ie. access to transportation or employment) and socio-economic status. The model was structured to produce a transportation network design that provides a higher and more equitable distribution of the satisfaction level index than a given baseline distribution of the same index. The design process is also guided by a weighting function which favors potential ridership with proportionately lower levels of satisfaction; design of the transit network is therefore tailored proportionately to the projected demands of the least satisfied people in an urban area.

The objective of the model is to design a transportation network configuration that will both increase and improve the equity of the baseline satisfaction level distribution. The model is flexible in that it may either design new systems or evaluate proposed improvements to an existing system from a socially relevant viewpoint.

Several experiments were designed and implemented to test some of the concepts involved and to determine the sensitivity of the model to changes in some of its key parameters. All aspects of these tests are documented in the report. Among the conclusions yielded were that the model does produce high performance network designs under a wide variety of conditions and that the resulting solutions with nearly identical performance measures indicated that there are probably a large number of good solutions to each problem.

Finally, the report concludes with a brief discussion of how the model can be expanded to contain additional factors relevant to urban transportation.

NTIS Order #: PB-199-290
PC \$3.00, MF 95¢

Title: "Regional Airport Planning: A Systematic Model" Occasional Paper #1.

Author: Richard Shinn (University of Washington at Seattle)

Date: May, 1970

Proj. #: URT-16

Keywords: 1. Airport, planning and operation

2. Community Response
3. Management, operations and techniques

Abstract: The purpose of this report is to outline and define a systematic model for analysis and planning oriented to solving the crucial issues facing aviation in large metropolises. This requires an understanding and an explanation of the history of regional response to airport issues in major air transportation hubs. It also demands perception of the issues within the 1990 time-frame. Regional aviation studies have been analyzed with emphasis being placed upon airport operating efficiency and short term development programs.

There are twenty-two large transportation hubs in the United States, with New York/Newark ranked first, each of which enplaned more than 1% of the passengers in the United States in the fiscal year 1966. These hubs included 173 airports which were open to the public and accounted for 68% of all domestic passengers and 79% of all domestic air cargo carried in United States scheduled airlines in FY 1965. Large hubs form the basic network of the national air transportation system.

The systematic model makes use of the eight steps in the regional airport planning process to group analytical tasks that are similar in analysis and timing. They are: (1) inventories, (2) forecasts, (3) analyses, (4) alternatives, (5) evaluations, (6) decisions, (7) development, and (8) operations.

Regional airport planning, as distinguished from planning of a single airport and planning of a national air transportation system, is found to be a relatively recent activity in most large metropolitan areas. A planning process with forums permitting the introduction of findings from studies of airport systems, environments and access systems is needed. In addition to gains from technological advances and development of air traffic potential, decision making for airport systems needs to be responsive to losses from delays on the ground and noise in the environment. A regional airport planning process can be divided into a study/planning phase and an operation/development phase, on the basis of agency types and particular types of participation. Joint agreements for operations that include development can be used to establish jurisdictions not legislated. Regional airport authorities are not expected to exist as a common solution to organizational problems in large metropolitan areas in the 1990 time-frame. Among the reasons for this conclusion are the difficulties involved in transferring large profit making airports to a new authority, or conversely, requiring that large, existing operators expand to include a host of airports which are not financially self-sustaining. Similarly, joint agreements for study of regional aviation issues and planning for a regional airport system are considered ample to assure continuity of regional airport planning. Investment decisions should remain with the developer, but other participants may contribute a frame of reference which will include both social cost accounting and broader rationale. The joint agreements for study, planning and operation are anticipated to be concurrent, recurring and interrelated by information flow in a systematic manner.

NTIS Order #: PB-198-597
PC \$3.00, MF 95¢

Title: "Design and Feasibility of a Mobile Overpass Road Repair Vehicle, MORV"
Author: Niranjan S. Choksi and Edmund C. Feldy (Illinois Institute of Technology,
Institute of Design)
Date: May, 1970 Proj. #: URT-20

Keywords: 1. Maintenance, equipment 4. Highway, maintenance
2. Maintenance, costs 5. Highway, surfaces
3. Traffic, control 6. Time Costs

Abstract: The report summarizes graduate research towards solving the problem of repairing multi-lane, high-density expressways without disrupting normal traffic flow. Statistical documentation illustrates losses in vehicle-hours and costs to both construction contractors and highway users from interruptions in highway capacity during repair work. The report also outlines guidelines and a design profile for development of MORV hardware. The latter includes: applicability of the design to elevated and curved roadways, versatility of the design in repaving different types of roadway surfaces, simplicity of mobility, etc. The report proposes a "design algorithm" for evaluating research information. The proposed vehicle is modular, designed as an overpass ramp which would permit traffic to drive over a highway repair site; the vehicle would self-contain repair machinery beneath its elevated ramp structure and would include off-road traffic monitoring and control equipment. The report details plans for the MORV structure, road repairs procedure, and traffic control around the unit. The authors emphasize that the proposed MORV is several years from final design, but suggest "the solution is presented in the form of a feasibility study for a machine which is felt to have the most potential for solving the problem."

NTIS Order #: PB-196-829
PC \$3.00, MF 95¢

Title: "Legal and Political Aspects of Free Transit in Major Metropolitan Areas"

Author: Robert W. Dillon and John A. Bailey (Northwestern University, Transportation Center)

Date: August, 1970

Project No. URT-21

Keywords:

1. Fare, cost determination	5. Government, urban
2. Social Benefits and Costs	6. Government, state
3. Center City	7. Government, taxation
4. Financing Mass Transportation, sources	8. Government, intergovernmental relations

Abstract: The report examines legal and political implications of proposed free transportation systems for metropolitan areas. Under these systems, public transit services would be financed entirely by public revenues, collected and administered on a regional basis. The Boston free transportation program was a selected case study.

Economic and social advantages of the proposal are examined with reference to fare collection cost savings, relief from transit robbery, faster service at reduced cost, improved accessibility within urban areas, rejuvenation of central cities, and reduced levels of air pollution and traffic congestion. Opposing arguments include increased operating costs, inefficient attainment of social welfare objectives, and the inequities of applying non user-oriented revenues to finance mass transportation.

Financial support is examined with reference to tax options of the center city and metropolitan districts. The statutory legitimacy of free transit is discussed with special attention focused upon "public purpose" and "home rule" requirements in existing legislation. The state-metropolitan political environment is also discussed. The authors conclude that free transit is socially desirable, but that necessary regional taxing powers can only be obtained from enabling legislation passed by the states. The state-urban cleavage thus represents the principal political obstacle to implementation of a comprehensive free transit program.

NTIS Order #: PB-208-246
PC \$3.00, MF 95¢

Title: "Stochastic Disaggregate Mode Choice Models: A Test of Three Hypotheses"

Author: John O. Lavender and Peter L. Stopher (Northwestern University, The Transportation Center)

Date: June, 1971

Project No. URT-21

Keywords: 1. Modal Split
2. Quantitative Analysis
3. Trip Generation

Abstract: The report examines three aspects of stochastic disaggregate mode choice analysis. This method attempts to predict an individual's choice among alternative transport modes for his trip to a given destination. Unlike conventional models which only correlate ridership volumes with personal and demographic characteristics, stochastic disaggregate analysis focuses upon causal variables and fundamental relationships by addressing itself to the unique choice environment of each individual.

The report emphasizes three basic questions in the development of stochastic disaggregate methods. First, the authors attempted to determine which of three analytic techniques performs best in calculating the proportions of a group which choose each specific mode. The techniques include: (1) discriminate analysis [which separates a heterogeneous group into subgroups according to a linear function of subject attributes], (2) probit analysis, and (3) logit analysis [which calculates the probability that an individual will make a specific choice given a set of values for relevant choice parameters].

Second, the authors attempted to determine whether differences, ratios, or logs of ratios between travel times and costs are superior in calculating mode choice. The third question involved the relative advantages of using stratified data.

A comprehensive literature search was conducted to determine the results of earlier studies in this field. The works of five major researchers are reviewed in detail. Data for the comparative analyses of stochastic disaggregate models were taken from the Chicago Area Transportation Study; a complete outline of research methodology is provided.

Specific results for each of the three questions are provided in detail. As anticipated, the logit and probit techniques proved more effective in replicating the actual modal split proportions, although all three methods performed well. No significant differences among the variable formulations (ie. differences, ratios, or logs of ratios) were revealed. Finally, the analysis yielded no advantages for using stratified data; age, income, and location proved to be significant determinants of mode choice for logit models, but a variable for sex did not appreciably affect the results.

NTIS Order #: PB-208-247
PC \$3.00, MF 95¢

Title: "Modal Choices and Travel Attributes of the Inner-City Poor"

Author: John Falcocchio, et. al. (Polytechnic Institute of Brooklyn, Department of Transportation Planning and Engineering)

Date: September, 1971

Project No. URT-29

Keywords: 1. Inner City
2. Poverty
3. Race
4. Trip Generation
5. Ridership, profiles
6. Modal Split
7. Fare, cost determination
8. Employment
9. Schedules and Scheduling

Abstract: The report is a comprehensive analysis of travel patterns among low-income residents of the urban inner city. Its purpose was to develop a thorough data base and to synthesize appropriate recommendations for improving public transportation services. The Brooklyn Central Model Cities area was the selected case study.

Data were obtained using standard survey techniques for several basic variables. A profile of inner city residents and their travel habits was developed with reference to: (1) race, (2) age distribution, (3) household size and median income, (4) occupational status, (5) automobile ownership, (6) trips per household, (7) trip purposes, and (8) modal split. The report also examines the types and location of land use activities which require public transportation access (eg. medical facilities, recreation, and shopping) and a description of existing transit services in the study area.

Several basic conclusions were yielded by the analysis: (1) Inner city residents travel less, simply because they have less money to spend on transit fares. (2) A further constraint to mobility is the multiple fare system which increases the cost of a trip according to its length. (3) Most inner city residents are transit captives, lacking adequate or reliable access to other transportation modes. (4) Trips by inner city residents for shopping, medical, and recreational purposes are of generally greater length than for all transit users. (5) As a consequence of these factors, inner city residents enjoy less mobility and suffer reduced opportunities for all trip purposes.

Five substantive recommendations are advanced: (1) Multiple-fare structures should be eliminated; (2) Off-peak service should be increased; (3) Group sharing of taxis at reduced fares should be permitted; (4) Transit lines should be re-routed to serve major trip generators; and (5) The coordination of service at major transfer points should be improved.

NTIS Order #: PB-206-149
PC \$3.00, MF 95¢

Index No. 4-00-29.1

Title: "Information Systems for the Urban Transportation Planning Process"

Author: Kenneth J. Dueker and Frank E. Horton (University of Iowa)

Date: June, 1971

Proj. #: URT-32

Keywords: 1. Management, operations and techniques
2. Management, planning and analysis
3. Urban Development, planning
4. Qualitative Analysis

Abstract: This report sets forth a framework within which an information system for the urban transportation planning process can be designed, constructed, and implemented.

In a systems analysis context, the continuing urban transportation planning process must be defined as a subsystem within the urban planning and management functions. Subsystem elements and interfaces (with other subsystems comprising the planning and management functions) must be made explicit. Design recommendations for information systems must weigh the cost of savings and other tradeoffs associated with a general purpose information system for urban planning and management and those related to systems designed for the specific needs of urban transportation planning. A constant problem in urban areas is the collection and analysis of data that describe changes in urban activities. Knowledge of changes within cities is extremely important in assessing spatial variation in the need, and thus the demand for urban services. Although it is fairly easy to see that urban transportation planners and city management have similar data requirements, there are subtle differences which do not always justify joint information systems. In addition to a commonality of need there are certain independent data collection activities occurring within metropolitan areas that could well provide useful socio-economic data for urban transportation planning and the continuing phase.

There are three dimensions or elements associated with urban transportation planning information systems: (1) a methodology for specifying a spatial location, (2) a phase which deals with temporal questions, and (3) a segment which is concerned with the kind of phenomena being observed. Methods of spatial location, often termed geocoding, refers to the means of specifying location in a machine-readable form. The frequency with which the data base is updated depends upon the use of the data and how frequently the specific phenomena observed changes status. Determination of the appropriate frequency for acquiring new imagery, surveys, or evaluating data from record keeping functions must be determined. The third information system, which deals with the kind of phenomena to be measured, contains an element that has continually plagued both the urban analyst and the transportation planner. While it is easy to point out that social, economic, and physical phenomena should be measured and integrated into information system files, specific identification of needed data and their attributes varies from city to city.

The authors have concluded that information systems for the urban transportation planning process do not pose difficult technical problems, but they do pose institutional and administrative ones where legal, organization, and coordination problems are the most significant barriers. Technical problems do exist, but technology has advanced enough to make a variety of data management systems with cities feasible though not necessarily acceptable within a particular institutional climate.

NTIS Order #: PB-204-420
PC \$3.00, MF 95¢

443

Index No. 4-00-32.1

Title: "The Attitudes of Drivers Toward Mass Transit"

Author: Frederick J. Beier (University of Minnesota)

Date: 1971

Project No. URT-36

Keywords: 1. Private Transportation, automobile 5. Ridership, attraction
 2. Private Transportation, driver 6. Time Costs
 3. Intermodal Competition 7. Community Response
 4. Surveys 8. Financing Mass Transportation

Abstract: The report is a study of the attitudes of automobile drivers toward mass transit in the Minneapolis-St. Paul metropolitan area. The author notes in his introductory text that public acceptance of urban mass transportation systems involves two fundamental dimensions: (1) willingness to allocate public resources to transit operation and improvement; and (2) desire to use the service available. These issues are of particular importance in the Twin Cities area where the municipality has recently acquired operation of the local bus system. The latter was to be underwritten with public revenues and financed by a "wheelage tax" (ie. a surcharge on licence plate fees). A recent court decision, however, had ruled this tax an unconstitutional departure from the concept of user charges. The University of Minnesota therefore undertook a comprehensive survey of Twin Cities residents to determine their attitudes about mass transit and the factors necessary for increasing ridership.

Questionnaires were sent by mail to a random sample of 600 area households selected from conventional Census tracts. The three basic objectives of the survey were to: (1) identify peoples' basic motives for driving; (2) examine the effect of "negative factors as a means of 'coercing'" drivers to use public transportation; and (3) evaluate positive influences to attract ridership. Survey methodology and a description of the sample are included in the report.

The survey revealed that eight factors were principal motives for automobile usage. These included (in order): speed, no waiting, freedom from schedules, greater reliability, protection from weather, personal enjoyment of driving, lower daily costs, and unfamiliarity with bus service. Four coercive factors were also highlighted, including increasing parking fees (\$4.00+/day), a requirement that cars in downtown traffic have more than one occupant, increased gasoline prices, and longer walking time between parking areas and downtown destinations. The most important positive factors among respondents who used public transportation were proximity to a bus stop, the ability to commute to work by transit, and speed.

The author concludes that three fundamental variables will control the extent to which improvements in public transportation systems can translate into increased ridership. These include: (1) a reduction of walking distances between bus stops and points of origin and destination; (2) elimination of travel delays incurred during transfer; and (3) increased speed.

NTIS Order #: PB-207-131
PC \$3.00, MF 95¢

Index No. 4-00-36.3

Title: "Comparative Analysis of Traffic Assignment Techniques for Transportation Planning With Applications"
Author: James W. Causey (Consortium of Universities, Urban Transportation Center)
Date: June, 1971 Proj. #: URT-37

Keywords: 1. Traffic, analysis 4. Highway, planning
2. Traffic, flow 5. Highway, types
3. Quantitative Analysis 6. Urban Development, planning

Abstract: The report is an evaluation of alternative traffic assignment techniques, with special attention given to application of the "all-or-nothing" (ie. free) approach. The location of a new highway link between a proposed freeway and the Baltimore, Maryland, central business district was a selected case study. The author hypothesized that even within congested urban travel corridors, certain routes would be underutilized and that new construction should emphasize links which will maximize the productivity of existing facilities. The report therefore examines traffic assignment models which effectively use underutilized segments of the present highway system.

Two alternate traffic alignments were tested. The first (System 12-5) utilized selected existing links as an integral part of the overall alignment; the second (System 12-6) utilized all new links. Thus the author was able to compare the effects generated by limited system components with those of the aggregate traffic network. Both macro and micro-scale analyses were undertaken to evaluate the performance of each technique.

On a macro-scale, the entire street and highway network was analyzed to determine how well each alternate system met certain predetermined goals as measured by existing evaluative criteria. The latter included such variables as vehicle-miles of travel, vehicle hours of travel, annual user costs, system costs, and computer time. All evaluation measures on the macro-scale demonstrated that System 12-5 contributed more significant improvements to the total network than System 12-6.

On a micro-scale, selected study sections were analyzed in detail using volume/capacity ratios and levels of service ratings as evaluative measures. All evaluation measures on the micro-scale revealed that System 12-5 was superior in using traffic assignment to optimize the productivity of network segments.

The author concludes that alignments using underutilized links made a significant contribution to the network of highways, while the other alignment did not when measured on both macro and micro-scales. The comparison demonstrated the advantages of making use of previously underutilized links of an expressway or arterial.

NTIS Order #: PB-204-936
PC \$3.00, MF 95¢

Title: "A Traffic Demand Analysis for the Proposed Visitor Center/Transportation Center/
Arena Complex, Union Station Site, Washington, D.C."

Author: Thomas P. Genis (Consortium of Universities, Urban Transportation Center)

Date: June, 1971

Project No. URT-37

Keywords: 1. Urban Development, planning 5. Trip Generation
 2. Surveys 6. Inner City
 3. Traffic, analysis 7. Interfaces
 4. Time Costs 8. Site Selection

Abstract: This report examines the transportation/traffic demand problems inherent in creating a combined visitor center, transportation center, and arena complex in the inner city area of Washington, D.C.

Various problems cited by the author in this study include: (1) non-existent connections between line haul modes, (2) an inefficient ground transportation system serving the proposed construction site, (3) limited interfaces to regional highway systems for buses and truck operations, (4) parking facilities for visitors in the areas of the proposed center, and (5) the need for transportation to and from Friendship and Dulles airports.

The author suggests that these problems can be solved with the aid of Congress through changes in land use, movement of the Government Printing Office, and appropriations for construction of transportation links vis-a-vis the centers and regional highway systems.

Maps, diagrams, tables, and charts are used to specify areas in which construction or land use changes are needed and also to predict the volume of people using these facilities over the next fifteen years. References are listed to indicate relevant source material.

NTIS Order #: PB-203-782
PC \$3.00, MF 95¢

Title: "Effect of Edge Marking on Narrow Rural Roads"

Author: Zuhair Y. Hassan (Consortium of Universities, Urban Transportation Center)

Date: June, 1971

Proj. #: URT-37

Keywords: 1. Highway, surfaces
2. Highway, types
3. Speed and Speed Control
4. Lane Separation
5. Private Transportation, driver
6. Quantitative Analysis
7. Traffic, analysis
8. Safety

Abstract: The report examines edge marking on narrow rural roads and its effect on the performance of highway users. Edge markers are usually white lines of two to four inches in width painted on narrow highway surfaces to delineate extremities of the pavement. The author cites background studies which demonstrated the effect of edge marking on traffic operation characteristics. The analysis focused on vehicle speeds and placement between lane dividers and the edge markers. Both studies concluded that speeds tended to increase on edge-marked roads, but they disagreed on whether drivers tended to move closer or further from marked edges. The purpose of the present report was to test those hypotheses.

Research methodology is described in detail. The author examined traffic characteristics on two segments of rural roadway both before and after edge marking was employed. Standard instrumentation was used to record vehicle speeds and placement under both daylight and nighttime conditions. A digital computer was employed for data analysis. The report contains all relevant statistics and reproductions of the actual computer print-out.

Two basic conclusions are advanced: (1) Edge marking was not found to have any significant effect on daylight traffic patterns. However, under nighttime conditions, a marked tendency for vehicles to operate closer to the center lane divider was revealed. (2) Speed measurements differed between the two test sections of rural roadway. However, the statistically significant increase in overall traffic flow on one road indicated that drivers may feel greater confidence when operating their vehicles over edge-marked roads.

NTIS Order #: PB-203-781
PC \$3.00, MF 95¢

Title: "The Balanced and Orderly Development of the Site in Close Proximity to a Metro Station as a Contributor to a More Healthy and Economically Viable Urban Environment in the Washington Metropolitan Area"

Author: Stanley Langfeld (Consortium of Universities, Urban Transportation Center)

Date: June, 1971 Proj. #: URT-37

Keywords: 1. Land Use 6. Site Selection
2. Land, acquisition 7. Government, urban
3. Housing 8. Rail, systems planning and design
4. Urban Development, planning 9. Rail, stations and terminals
5. Community Response 10. Rights-of-Way

Abstract: The report analyzes land use development in proximity to rapid mass transit routes with special reference to the site proposed for one station of the Metro system under construction by the Washington Metropolitan Area Transit Authority. Two principal goals of the research were to study land use experiences in other cities with similar transit systems and to synthesize recommendations for the "balanced and orderly" development of sites adjacent to the Metro Station. The latter is to be located in North Bethesda, Maryland; the examples are San Francisco and Toronto.

The report attempts first to assess the relationship between construction of rapid mass transportation and surrounding land use and property valuation. The fundamental conclusion drawn from this analysis is that increased accessibility (provided by transit) shifts human activities to the most accessible locations, promoting more intensive land use and subsequently greater land values. Data collected from the San Francisco and Toronto examples are discussed in support of this contention. Photographs showing the changes in land use before and after transit construction are also provided.

Methods for ensuring orderly and balanced development in close proximity to rapid transit stations are contrasted between the two cities. In both cases the author concludes that effective control of development patterns was achieved. In San Francisco, the method employed was incentive zoning of land adjacent to the proposed BART (Bay Area Rapid Transit) system. Zoning regulations were carefully planned to stimulate desired patterns of land use and construction, enforced by law. In Toronto, less formal controls were established under which the municipality acquired wide strips of land in which transit rights-of-way were to be located. Surplus land was then parceled out by the municipality for private development on a long-term lease basis, pending approval of a regional planning body.

The report follows with a comprehensive description of the North Bethesda site, with reference to existing land use, assessed valuation, and zoning. The author also examines potential growth and development of the area, noting that the Transit Authority has only purchased the land necessary for construction of the station. As a result, the zoning alternative for controlled land use development will have to be used, and the report analyzes the impact of two possible zoning laws, one providing for purely residential uses and one for a residential-commercial mix. Ancillary development requirements, such as public facilities and parking, are compared between the two alternatives. The author concludes that control of the "transit impact zone" will result in a balanced and orderly development of the sites in proximity to the proposed station.

NTIS Order #: PB-203-783
PC \$3.00, MF 95¢

Title: "Economic Information for Environmental Quality Management"
Author: Inja K. Paik (Consortium of Universities, Urban Transportation Center)
Date: June, 1971 Proj. #: URT-37

Keywords: 1. Noise and Noise Control 4. Quantitative Analysis
2. Air Pollution 5. Qualitative Analysis
3. Environment and Environmental Control 6. Quality Control

Abstract: The report develops inputs for a quantitative model with which to assess the economies of environmental quality management. Particular emphasis is placed upon environmental diseconomies (eg. water, air, and noise pollution) caused by transportation systems. The principal objective of the report is to quantify the costs of ecological neglect which are not otherwise reflected in prices or other standard economic indicators. The author's model, however, is adaptable to measure the cost of environmental deterioration caused by all sectors of the economy.

In particular, the report cites a need for adequate sources of information with which quality control managers can estimate these environmental costs. Two basic types of data are examined by the author, including: (1) a substitute for conventional national income accounting which would subtract for the depreciation of environmental resources; and (2) a value which estimates the effects of environmental quality maintenance in overall economic growth accounting. The report particularly emphasizes this latter point because the economic effects of environmental protection are not reflected in conventional economic indices. The author therefore introduces methods by which savings in terms of natural resources and indirect social benefits can be quantified to offset higher production costs incurred under pollution control programs.

Several analytical models are discussed, including the Leontief input-output model, an expanded Leontief equation, econometric models, and hybrid methods combining two or more conventional models. In general, these models are used to estimate the interrelationships among related industries and the responsiveness of different economic sectors to output variables arising elsewhere in the system. The expanded Leontief equation adds anti-pollution activities and pollution coefficients to an existing input-output table to permit evaluation of ultimate industry-by-industry effects of alternative environmental quality controls.

In advancing criteria for the necessary data inputs for these models, the author cites a need for standardized measurements and coordination of previous studies. The report concludes with a classification of quantifiable benefits which includes: reduction in human health costs, increased recreational opportunities, effects on animals and plants, and effects on property valuation. These variables are arrayed as primary costs, secondary effects, effects on other pollutions, and such other costs as public administration. In addition, the author suggests guidelines for conducting case studies in selected high-pollution industries. The report does not advance a specific quantitative equation, but rather is concerned with the informational inputs to such an equation.

NTIS Order #: PB-203-784
PC \$3.00, MF95¢

Title: "Selected Sources of Non-Farebox Revenue for Metro: Landover and
Huntington Stations"
Author: George T. Pappas (Consortium of Universities, Urban Transportation Center)
Date: June, 1971 Proj. #: URT-37

Keywords: 1. Financing Mass Transportation, sources
2. Advertising and Promotion
3. Rail, stations and terminals

Abstract: The report examines sources of non-farebox revenues for rapid mass transit and evaluates their potential application in the Metro system now under construction in Washington, D. C. The author focuses particularly upon two conventional revenue sources, concessions (ie. in-station services not related to the transportation function) and advertising. Two proposed Metro stations at Landover, Maryland, and Huntington, Virginia, were selected case studies.

The author notes that such variables as station design, peak-hour trip generation, and parking facilities at any given station will yield different opportunities for exploiting sources of non-farebox revenue. The report includes detailed descriptions of each station under study with reference to potential locations for advertising displays and concession stands. Textual material is supplemented with architects' drawings of the proposed design.

The report also compares the experiences of eight other transit systems in North America with advertising and concessions. For each of the properties surveyed, the author documents net revenues from all sources along with a description of the services provided. Advertising generally consists of wall-mounted posters or cards displayed within the trains. Concessions include newsstands, vending machines, luncheonettes, coin lockers, pay telephones, booth rentals, and various other passenger amenities.

The author concludes that the Landover site will provide space for 20 advertising displays yielding gross monthly revenues of \$700; the Huntington station provides space for 23 displays at \$805 monthly. Specific recommendations for locating advertising spaces in the stations are appended. Five typical concessions are also examined, including: (1) vending machines; (2) newspaper sales; (3) pay telephones; (4) an automobile service station [in conjunction with park-and-ride or kiss-and-ride facilities]; and (5) dry cleaning services. In each case the author provides estimates of gross revenues at the two stations based upon standard patronage-forecasting techniques. A total of some \$20,000 annually could therefore be generated for Metro at each station by leasing space for advertising and concessions.

The report does not attempt to advance specific policy recommendations for Metro; rather, its purpose is to explore potential revenue sources and to suggest in general terms their probable application.

NTIS Order #: PB-204-935
PC \$3.00, MF 95¢

Title: "Metro Impact in Arlington County: A Case Study and Evaluation of a Transit Growth Model"

Author: Edward D. Studholme (Consortium of Universities, Urban Transportation Center)

Date: June, 1971

Project No. URT-37

Keywords: 1. Urban Development, planning 6. Corridors
2. Housing 7. Employment
3. Demography 8. Government, county
4. Quantitative Analysis 9. Government, urban
5. Land Use

Abstract: The report is a critical evaluation of the growth model used to estimate transit impact in Arlington County, Virginia, following completion of the Metro rapid transit system. The author concludes that present impact forecasting is based only on the direct consequences of increased accessibility which Metro will afford to area residents. Such projections ignore the "ultimate impact" of increased opportunities for growth in all sectors of the surrounding community. The purpose of this report is to evaluate two proposed impact models with reference to the ability of existing public policies to control anticipated growth in proximity to planned rapid transit stations.

Four basic developmental variables were identified, including: (1) population size, (2) population and building density, (3) land use zoning, and (4) circulation and mobility. Within these parameters, Model I was developed by public officials to estimate probable rates of growth throughout Arlington County following completion of the Metro. The author notes, however, that minimum estimates generated by Model I exceeded maximum water and sewer capacities by 15%.

It was therefore necessary to adopt Model IA which incorporated the following changes: (1) Maximum employment growth was restricted to 67,000 persons; (2) Allowable residential construction was reduced by 10,000 dwelling units; (3) Total population allowances were cut by some 30%, with greater emphasis on commuters than workers employed within the county; and (4) A greater allowance for auto commuters was included. Despite these changes, the author concludes that Model IA faces severe implementation problems.

The report challenges several basic planning assumptions in Model IA with reference to: (1) projected demography and demand, (2) market aggregation, (3) residential construction, and (4) commuter modal split. The author maintains that population forecasting in Model IA is based on transportation access and water and sewer capacities, neither of which are good predictors of residential growth. In addition, the county-wide transit demand will be highly concentrated in three specific corridors such that overall modal split may be subject to significant variations from Model IA estimates. Furthermore, the Model predicts that some 42% of all employed residents will work within the County. However, for every resident employee lost to a job outside the corridor, four work trips are generated, and probable errors in the initial forecasts may result in sizeable future variations. Implementation problems are also discussed briefly with reference to the county zoning process.

The report also provides an in-depth analysis of Model IA which focuses on the fiscal aspects of simultaneous commercial and residential construction. The author concludes that several factors delimit housing potential, although a controlled and growing volume of residential land usage is essential to the Model. All relevant equations and data are provided.

NTIS Order #: PB-204-934
PC \$3.00, MF 95¢

Title: "The Evolution of the D. C. Highway System"
Author: Gerald C. Tuzo (Consortium of Universities, Urban Transportation Center)
Date: June, 1971 Proj. #: URT-37

Keywords: 1. Highway, planning 6. Rail, systems planning and design
2. Highway, types 7. Land Use
3. Urban Development, planning 8. Demography
4. Corridors 9. Government, urban
5. Center City

Abstract: The report traces development of transportation arteries in the Washington, D. C. area since the late 18th Century and projects future demands through the 1990's. The report notes early city planning which emphasized a system of broad avenues cutting across a grid of perpendicular streets. The patterned growth of this system to meet demands generated by increasing commercial and residential construction throughout the 19th Century is examined with frequent citations from Acts of Congress, planning reports, and the City budget. Particular attention is given to the responsiveness of this growth and connections between outlying developments and the central city.

The report also discusses planning in the early 1900's, with reference to the demands for streets and highways generated by introduction of the automobile and mass public transportation. At that time, the city was faced with four long-range planning alternatives. These included: (1) planned sprawl, (2) dispersed cities, (3) peripheral communities, and (4) radial corridor development. The author concludes that subsequent programmed and planned highway facilities have generally supported the latter concept, and he notes particularly plans for nine controlled-access freeways to serve seven radial corridors.

The report maintains, however, that construction of the radial freeways which are basic to the corridor development concept has been accomplished with only limited success. Consequently, the proposed radial corridor areas lack the necessary accessibility to downtown Washington and do not, therefore, encourage patterned urban development.

In lieu of such highway construction, the report analyzes proposed rail rapid transit scheduled for completion before 1980. The author notes potential radial applications for the transit network to connect planned circumferential highways with the central business district. However, the present transit routing will not extend service beyond the Capital Beltway (Washington's major existing circumferential expressway), and thus before 1980, highway construction must be relied upon to guide the development of outlying areas. The author also notes that emphasis on circumferential links will encourage growth outside planned corridors in the wedge areas originally contemplated for no (or highly restricted) urban development.

The report concludes with an analysis of alternatives for extending the present network to encourage radial corridor development beyond the Beltway prior to 1980. The author notes that buses and commuter rail rights-of-way could be used to supplement the authorized transit system in this area. He also concludes that current and projected transit service within high-density activity centers will be sufficient to meet demands through the 1980's.

NTIS Order #: PB-203-935
PC \$3.00, MF 95¢

Title: "The Views and Values of the Community Effected by a Major Transportation Project"

Author: Charles R. Ryan (University of Wisconsin at Milwaukee)

Date: January, 1972

Project No. URT-44

Keywords: 1. Highway, planning
2. Community Response
3. Quantitative Analysis
4. Demography
5. Surveys

Abstract: This research examined the feasibility of using social diagnostic techniques as a means of gathering data for dealing with problems raised by the construction of new highway facilities. The Milwaukee area was a selected case for the application of systematic survey procedures designed to assess public attitudes and values. The surveys produced a detailed demographic profile of the study area and a delineation of public attitudes on a variety of major issues.

A multivariate analysis was conducted to identify significant relationships between demographic and attitudinal variables; age was found to be the factor most closely associated with support for or opposition to proposed construction. The report focuses particular attention upon public attitudes towards both transportation-oriented and non-transportation issues. In a broader context, the research demonstrated a methodology with which community attitudes can be assessed and predicted for transportation planning and conflict-resolution.

NTIS Order #: PB-210-563
PC \$6.00, MF 95¢

Title: "The Planning of Node Oriented Transit Systems: An Application of Man-Machine Interactive Problem Solving -- Research Report #3"

Author: Mattias H. Rapp (University of Washington)

Date: 1970

Project No. URT-49

Keywords: 1. Computer, applications
2. Computer, programming
3. Routes and Routing
4. Modal Split
5. Trip Generation

Abstract: The problem of finding the best fixed routes for node oriented transit systems is used for an initial implementation and evaluation of a man-machine interactive problem solving system. Node oriented systems imply the convergence of trip ends at a distinct location -- that is, many-to-one and one-to-many systems. The interactive graphic system enables a planner/analyst to effectively search for and evaluate a large number of alternative designs in a short period of time. This evaluation is based on a modal split model which predicts the system utilization and cost consequences of each alternative design. The model performs a detailed analysis of the components of the trip of each potential tripmaker by the alternative modes of travel by transit or private automobile, and it is based on values reflecting the average tripmaker's perception of disutility of the various trip components.

After a conceptual discussion of the problem, the interactive graphic problem solving environment, and the model underlying the prediction process, the mechanics of the actual implemented system are described, both in terms of computer hardware and software features. The use of the system is then illustrated with a hypothetical problem situation, and the ability of the interactive process to assist the resolution of conflicting objectives, and to help a policy making body to reach compromises after a value-oriented discussion is examined. Finally, the paper discusses some issues raised in the prototype analysis relative to: (1) the role and performance of the human in the interactive process, (2) alternative solution generation schemes, and (3) model calibration.

NTIS Order #: PB-199-122
PC \$3.00, MF 95¢

Title: "Interactive Editing of Transportation Networks Research Report No. 4"

Author: Mathias H. Rapp (University of Washington)

Date: December, 1970

Proj. #: URT-49

Keywords: 1. Computer, application 4. Urban Development, planning
 2. Computer, programming 5. Algorithms
 3. Codes and Coding 6. Dual Mode Systems

Abstract: The purpose of this report is to present a conceptual approach to interactive network editing. It discusses the selection of an appropriate data structure for representing the network in the computer memory, and it describes the algorithms that perform the various editing functions. Finally, it illustrates the methodology by discussing the capabilities and the mechanics of a prototype interactive network editor developed at the Urban Systems Laboratory of the University of Washington.

Urban analysis, in particular urban transportation systems analysis, often deals with an existing or proposed transportation network. This network may be either unimodal or multimodal. A unimodal network would be a network comprised of just one mode, the street system of an urban area, whereas a multimodal network would combine the networks for two or more modes of transportation. For purposes of analysis the physical or real-world network is abstracted to a coded network which consists of straight line segments terminated by points called nodes. The line segments between nodes are termed arcs. Types of analysis requiring a coded transportation network are: the finding of the shortest distance between two nodes of the network, determining paths with certain properties between two nodes, or determining the network flow capacity between two nodes. Coded street networks have other applications such as the geocoding of urban data for the purposes of spatial analysis, graphic display, and data retrieval for urban systems modeling.

A coded network is usually edited by means of automated graphic display, and errors are corrected through a manual coding process. The network editor is a computer assisted error detection and updating system which will be applicable to the editing of newly created networks and to the updating and maintenance of existing networks. The quality of a coded network is a function of the absence of the three classes of network errors as follows: (1) topological errors, such as the erroneous absence of an arc or a node; (2) geographical errors, such as the geographical misplacement of a node; and (3) attribute errors, such as the coding of erroneous arc or node names, codes, or properties. Depending on the type of network analysis method the three classes of errors have various impacts on the results. Topological errors will have a global impact, attribute errors a local impact, and the geographical errors will often have no impact other than a distorted graphic display of the otherwise error free results. For most network analysis tasks the network should be one hundred percent topologically error-free.

Experience with geocoding networks that are by nature of substantial magnitude leads to the conclusion that graphic editing is the only feasible procedure to achieve high-quality coded networks. Graphic editing, in this context, means any procedure which leads to a comparison between the original maps of the network and an automated display of the coded network. The editor would enable a user to interactively manipulate all elements of a network, the network nodes and the network arcs. Each editing function would be performed independently upon a user initiated command, by typing an editing order and selecting the element to be manipulated with either the cursor or by typing the element's identification number.

NTIS Order #: PB-199-399
PC \$3.00, MF 95¢

Title: "Designing Urban Transit Systems - An Approach to the Route-Technology Selection Problem, Research Report No. 6"

Author: John C. Rea (University of Washington)

Date: August, 1971

Proj. #: URT-49

Keywords: 1. Computer, application 4. Trip Generation
 2. Computer, programming 5. Routes and Routing
 3. Ridership

Abstract: The purpose of this report was to develop a screening model for the design of public transportation systems. The model's function would be to define transit system configuration and equipment usage subject to given policy constraints and available hardware systems. There are three basic inputs to the model. The first describes the potential transit network; the second describes the proposed hardware systems and operating methods, and the third describes the size and orientation of the transit demand.

The basic concept of the model is a service specification which integrates hardware system attributes and operating policy. A service specification is an integrated set of statements which describe the particular hardware system operating at a given service frequency which is planned for use on links having a given range of flow level. Walk mode may be included in the specification for the lowest range of link flows. The model defines a transit system with a (template) network which includes all potential transit links. The template network may be planar or non-planar and may include existing transit facility links. The mechanism of the model is an iterative assignment process similar in concept to the capacity restraint mode. The template network is initialized at the "best" hardware system-service frequency combination. The link hardware system and headway are iteratively adjusted to correspond to link flow level as specified by the service specification. The iterative process ends when no further changes in link "status" are required.

The author concluded that the concepts encompassed by the service specification model are viable and that the model constitutes a practical planning tool. The transit system defined by the model is not necessarily optimal but is at least a feasible solution conforming to the narrow constraints imposed by the service specification. Since an empirical testing approach was used, it was not possible to define how "good" was the solution produced by the model. The result is a feasible solution conforming to the severe constraints imposed by the service specification. The model appears to be a potentially useful tool for generating and evaluating alternative transport systems not only in urban transit design but also in any context for which a service specification can be formulated.

NTIS Order #: PB-204-881
PC \$3.00, MF 95¢

Title: "A Quest for Integrated and Balanced Transportation Systems in State Government"

Author: Richard G. RuBino (Florida State University, Transportation Center)

Date: June 30, 1971

Project No. URT-52

Keywords: 1. Government, Federal
2. Government, state
3. Government, intergovernmental relations
4. Financing Mass Transportation, sources
5. Urban Development, planning
6. Budgets and Budget Planning
7. Surveys
8. Intermodal Competition

Abstract: The report is a detailed analysis of state Departments of Transportation (DOT). The author identifies "balanced transportation systems" as a basic national objective with which to evaluate state transportation policy and planning agencies. Three principal obstacles to effective programming are noted: (1) The functional division of planning authority by mode has encouraged inter-agency competition and hindered effective policy coordination. (2) The lack of a general transportation trust fund has created an unbalanced financing of certain modes and precipitated undesirable competition for limited state funds. (3) Federal policy control has not sufficiently encouraged the role of state DOT's to the detriment of intergovernmental cooperation.

State DOT's are relatively new governmental units, developed largely in response to the rapid urbanization and increased public mobility experienced by many states. The present role of DOT's is examined with particular emphasis on 13 case studies. The report notes a wide diversity among these organizations with reference to structure, scope, authority, and place in overall state administration. While most integrated control of highways, aeronautics, and mass transit, the study revealed several examples of fragmented authority.

The evaluation procedure employed survey data collected among DOT personnel in nine state governments. While reactions were mixed, a majority of respondents felt that only limited progress had been made towards achieving the goal of balanced transportation. Executive leadership in state DOT administration is discussed in detail with particular emphasis on the budgetary process. The author concludes that state transportation officials frequently lack sufficient influence on legislative budget allocations to secure requisite funding for their programs.

Planning and policy-making structures are also examined in detail. Questionnaires circulated among state DOT personnel revealed that many were pessimistic about their relations and coordination with comprehensive state planning bodies. The author also examines the division among policy-making, policy-implementation, and long-range planning functions.

Five general recommendations are advanced to improve the effective planning of balanced transportation systems in state government. (1) The sharing of special Federal transportation revenues with the states is encouraged. (2) State DOT's should be given comprehensive authority over all modes, including ports and river transportation. (3) Direct Federal-state planning and technical assistance should be instituted. (4) Leadership of state DOT's should be consolidated under a single executive empowered to direct both policy-making and budgetary allocations. (5) State DOT activities should be directly coordinated with comprehensive planning bodies and the budgetary apparatus.

NTIS Order #: PB-203-907
PC \$3.00, MF 95¢

Title: "The Permanence of Trip Generation Equations -- Report #6"
Authors: Norman Ashford and Frank M. Holloway (Florida State University, Transportation Center)
Date: August, 1971 Proj. #: URT-52

Keywords: 1. Trip Generation
2. Quantitative Analysis
3. Surveys

Abstract: The report examines trip generation models to determine whether their reliability declines over time. The authors note that existing equations were developed within the context of specific sample data and have subsequently received only limited review. Follow-up testing of land use models has shown them to be relatively stable over a span of several years. On the other hand, travel time equations are related to the size and spatial relationships of an urban area and therefore subject to extreme influence over time as the area develops. A principal objective of the present study is therefore to evaluate descriptive and predictive capabilities of a trip generation model after the passage of several years.

The report focuses on a model developed in 1958 using data collected in the Pittsburgh metropolitan area. Equations for linear regression analysis were derived which related trip generation to eight independent variables including: (1) number of dwelling units, (2) population, (3) licensed drivers, (4) automobile ownership, (5) residential acres, (6) population density, (7) age distribution, and (8) distance from central business district. The authors then employed the model using similar data collected in 1967. In both samples, trip generators were classified to yield trips in several categories for detailed study. These included primary, secondary, and "other" work trips, home based non-work trips, and a residual category combining school trips and miscellaneous data.

Survey procedures and results broken down by zones are outlined in detail. To compare performance of the model in estimating trip generation for each set of data, random samples of nearly 800 households were selected and analyzed with reference to persons per household, automobile ownership, proximate residential density, and travel distance from the center city. The comparison was made using a "dummy variable technique" which measures significant differences between the regression constants of conventional multiple regression equations.

The authors conclude that significant variations were yielded, indicating that the model developed in 1958 was not accurate when applied to the more recent data. The tendency was to either overestimate or underestimate the 1967 productions over the whole range of observed values. Maximum discrepancy was obtained with the home based school trip model which predicted only 72% of the observed productions. The home based work model overestimated production by some 15.4%. Interestingly, the authors observed that overall trip generation was underestimated by only 2.4%, indicating that discrepancies for each type of trip balanced out in the aggregate. The report concludes that trip generation models do not enjoy permanent applications, and that performance tends to diminish over time.

NTIS Order #: PB-204-433
PC \$3.00, MF 95¢

Title: "Bus Priority Strategies for Downtown Washington"

Author: Arthur J. Smith (Consortium of Universities, Urban Transportation Center)

Date: May, 1972

Project No. DC-URT-3

Keywords: 1. Bus, priorities
2. Lane, reserved
3. Center City
4. Traffic, flow
5. Traffic, peak-hour

Abstract: The report examines bus priority strategies for downtown Washington, D.C. Several basic goals governed the development of two alternative bus priority models. These generally embrace improvements in public mobility and center city access, optimized traffic circulation, and reduced air pollution.

The theory and practice of bus priority systems is explored in detail with reference to design factors, interaction between transit vehicles and conventional traffic, location, parking facilities, and traffic engineering. Bus priority applications in other cities are reviewed briefly.

Two general bus priority models for Washington are advanced. The first makes extensive use of reserved traffic lanes for buses during peak periods. The second proposal employs a combination of conventional reserved lanes and a core of special "bus only" streets on which normal traffic would be prohibited. The author concludes that this latter model would maximize transit service to downtown Washington with a minimal disruption of traffic flow on other streets. The report focuses particular attention upon the operation of bus priorities on specific streets and corridors in the Washington area.

NTIS Order #: PB-210-172
PC \$3.00, MF 95¢

Title: "A Factor Analysis of the Tendency of Shirley Highway Commuters Not to Ride a Transit Vehicle"

Author: David L. Jones (Consortium of Universities, Urban Transportation Center)

Date: May, 1972

Project No. DC-URT-3

Keywords: 1. Bus, commuter
2. Bus, express
3. Bus, priorities
4. Quantitative Analysis
5. Private Transportation, driver
6. Time Costs
7. Ridership, attraction
8. Surveys
9. Public Relations

Abstract: A factor analysis of 24 related variables was performed using survey data to identify the most significant elements in the decisions of Shirley Highway commuters not to ride a transit vehicle. The author briefly describes the Shirley Highway Express Bus-On-Freeway demonstration project which attempted to divert automobile commuters to transit by providing special, reserved bus-lanes.

Techniques used for data collection and analysis are described in detail. The findings reveal five crucial factors related to persistent automobile ridership: (1) belief that the automobile is the fastest and most economical commuter mode, (2) affluence of the commuter, (3) inconvenience of transit to place of employment, (4) general public antipathy towards commuting, and (5) the negative image of the transit company.

The author concludes that if his results are replicated by further studies, several specific recommendations should be considered. These include improved time and cost savings, increased emphasis on speed and frequency, increased attention to the travel habits and desires of affluent commuters, improved routing to downtown destinations, and increased public relations programming. The author underscores his finding that Shirley Highway commuters evidence more interest in convenience and cost factors than in comfort or other amenities. The author also concludes that the general effectiveness of the survey and factor analysis techniques was demonstrated.

NTIS Order #: PB-210-413
PC \$3.00, MF 95¢

Title: "A Transit System in Crisis, A Case Study of D.C. Transit"

Author: Joseph A. Artabane and Francis J. Nealon (Consortium of Universities, Urban Transportation Center)

Date: June, 1972

Project No. DC-URT-3

Keywords: 1. Bus, cost
2. Public Ownership
3. Government, Federal
4. Financing Mass Transportation
5. Management, operations and techniques

Abstract: The report examines the D.C. Transit system which provides bus service in the District of Columbia. The authors note that serious financial problems threaten the continuation of this service, and that construction of the Metro rapid transit system will require special efforts to coordinate public transportation.

The report begins with an overview of mass transit in Washington, D.C. The authors note that while many problems of the D.C. Transit Company are endemic to the transit industry nationally, other problems are related directly to the unique employment and regulatory situation in the Nation's Capital. The analysis focuses upon six major topics: (1) a history of mass transit in Washington, (2) a brief financial history of D.C. Transit, (3) a description of other transit companies operating in the area, (4) legislation and operations of the Metro rapid transit system, (5) transit regulation in the District of Columbia, and (6) the politics of transit in Washington.

The authors particularly emphasize the need for coordinated service between the bus and rapid transit systems. They conclude that public acquisition of the D.C. Transit system is warranted. In support of this conclusion, the authors discuss financial justifications for public takeover with reference to the present financial crisis of the private operator, the disadvantages of accepting a proposed 50¢ fare, and the resultant need for public ownership. The report contains detailed statistical and economic data.

NTIS Order #: PB-210-999
PC \$3.00, MF 95¢

Title: "The Travel Patterns of Persons Residing in High-Density Urban Areas"

Author: Richard F. Bailey, et. al. (Polytechnic Institute of Brooklyn)

Date: June, 1972

Project No. NY-URT-7

Keywords: 1. Urban Development, renewal 5. Modal Split
 2. Housing 6. Trip Generation
 3. Surveys 7. Ridership , profiles
 4. Demography 8. Quantitative Analysis

Abstract: The report examines travel patterns of persons residing in high-density urban areas. The authors focus particularly upon the construction of high-rise housing developments as a form of urban renewal which can significantly affect local population densities and create major new demands for public services, especially transportation.

The purpose of the report was to develop a model with which to project the transportation requirements of persons residing in such high-density areas. Three secondary objectives were to: (1) generate various regression equations that could predict the number of trips per dwelling unit; (2) validate existing regression techniques; and (3) indicate possible applications of the data collected. The authors hypothesize that if the travel habits of high-rise dwellers can be determined, the integration of urban renewal and transportation plans can be facilitated.

The report utilized a comprehensive transportation planning procedure divided among four basic phases. These include: (1) an inventory of existing conditions; (2) future public policy decisions; (3) estimates of future urban area growth; and (4) estimates of future travel demands. These basic variables were used to synthesize data inputs to the model.

The authors provide a brief history of the study area and a detailed analysis of its existing facilities. The Coney Island section of Brooklyn, N.Y., was selected because it contained four major high-rise housing developments and an ample public transportation system. A survey of local households was conducted using two types of questionnaires. A "long form" was employed to obtain general information about persons in the study area; a "diary" format was used to record data about various trips made during the study.

A detailed expansion procedure was developed to apply the sample data to larger areas. All relevant equations and data tables are reproduced in the report. In addition, a regression analysis was used to correlate the relationships among different observed characteristics. All but one of the equations proved to have replicative value, and the authors conclude that their model was an adequate predictor of transit demand.

NTIS Order #: PB-207-179
PC \$3.00, MF 95¢

Index No. 4-NY-7.2

465

Title: "Design of a Freeway Entrance Ramp Merging Control System"

Author: Harold J. Klee (Polytechnic Institute of Brooklyn)

Date: September, 1971

Project No. NY-URT-7

Keywords: 1. Traffic, flow
2. Traffic, control
3. Access, planning and control
4. Meters and Metering
5. Sensors
6. Vehicle, monitoring
7. Highway, types
8. Quantitative Analysis

Abstract: The report explores methods to optimize and control the merging of vehicles from a freeway entrance ramp. The author notes that as freeway traffic volumes approach saturation, merging vehicles on the access ramps experience fewer acceptable gaps in the right lane flow and hence an increased delay time. These factors combine to create a non-optimal merging pattern caused by drivers who reject acceptable gaps or attempt the merging maneuver at inopportune moments. The report also notes that many rejected gaps could be accepted if vehicles at the ramp "nose" were in motion, and that many merging accidents could be prevented if they were not. The purpose of the report was therefore to develop a merging control system which would permit drivers to enter the freeway traffic flow safely and in smaller acceptable gaps.

The author briefly examines previous studies of controlled merging in the literature, but concludes that existing models are not suitable to optimize and control overall traffic flow. The report examines the potential improvement in operating performance of an entrance ramp equipped with a gap acceptance controller. Simple metering is also included, and ramp vehicle delay curves for both modes of operation in addition to uncontrolled merging are presented. The author focuses particular attention upon synchronization of the merging vehicle and acceptable freeway gaps. A separate chapter is devoted to modeling the significant features of the merging process (ie. gap propagation and ramp vehicle travel time).

The report presents a technique for approximating the gap propagation probability functions which are fundamental to any determination of optimal release times from the ramp of vehicles in the gap acceptance control mode. Attention is focused on the problem of locating the freeway sensor. The author also provides a quantitative illustration noting the application of the synchronization algorithm.

A major advantage of the method is that it takes into account vehicular interaction within platoons, a factor which the author believes is fundamental to any description of the actual merging process. The method thus developed represents a significant improvement over existing techniques by permitting merging vehicles to accept smaller gaps safely while merging into the freeway flow.

NTIS Order #: PB-206-239
PC \$3.00, MF 95¢

SECTION II: The Indexes

TITLE INDEX

Entries in this index are listed alphabetically. Occasional duplication of page numbers occurs where two or more reports were included on a single abstract.

TITLE INDEX

	<u>PAGE:</u>
A.C. Traction Power Collection -- Report #7	7
Acceleration and Comfort in Public Ground Transportation	290
Acoustics Studies -- Report #8	8
Acquisition and Public Operation of Transit Services in Providence-Pawtucket Metropolitan Area	117
Action Program for Transit Improvement, An	232
Adhesion Characteristics -- Report #9	9
Advanced Control Technology in Urban Traffic Control Systems -- Volume I: System Description	314
Advanced Control Technology in Urban Traffic Control Systems -- Volume IA: Bus Priority System Description	315
Advanced Control Technology in Urban Traffic Control Systems -- Volume II: UTCS/BPS Programming Specifications	316
Advanced Control Technology in Urban Traffic Control Systems -- Volume III: UTCS/BPS Equipment Specifications	317
Advanced Urban Transportation Systems: Proceedings of the Carnegie-Mellon Conference on Advanced Urban Transportation Systems	392
Advertising and Promotion Demonstration Program (Final Report)	113
Aerial Structure and Rail Support Methods -- Report #11	11
Air Conditioning Study of the New York City Transit System -- Part I: A Thermal System Model and Equipment Valuation, An	100
Air Conditioning Study of the New York City Transit System -- Part II: Feasibility of a Thermoelectric Air Conditioner for Subway Cars (Final Report)	101
Air Cushion Vehicle, Port of Oakland (Final Report)	13
Airport Access in the Baltimore-Washington Region: Immediate-Action Improvement Program and Planning Guide	318
Alden Capsule Transit System Control Subsystem and Baseline Definition	277
Analysis and Requirements of Electronic Command and Control Systems	361
Analysis of Peak Period Passenger Flows on the Lindenwold Rapid Transit Line	405
Analysis of Public Transit Legislation	252
Applicability of Data Compression Schemes to Urban Location and Communications Systems, The	67
Application of Improved Management Methods to the Urban Transportation Industry - Monograph #4	344
Application of Scaling Data to Model Tests to Obtain Full-Scale Results -- Interim Report	43
Areawide Mass Transit Planning Study -- Planning Series Report #5: Plan Development	150
Areawide Mass Transit Planning Study -- Planning Series Report #5: Plan Development; Supplement A; Field Surveys	151
Arriving Late in Suburbia: The Buttonwoods-Providence Express and Local Shoppers' Shuttle (Final Report)	118
Atlanta Plan: Rapid Transit for the People, The	173
Attitudes of Drivers Toward Mass Transit, The	444
Automatic Fare Collection -- Technical Report #2 (Final Report)	2
Automatic Train Control -- Technical Report #1 (Final Report)	1
Automatic Vehicle Monitoring Technology Review	331

Balanced and Orderly Development of the Site in Close Proximity to a Metro Station as a Contributor to a More Healthy and Economically Viable Urban Environment in the Washington Metropolitan Area, The 448

Baseline System Definition of the Aerial Transit System 276

Baseline System Definition: Urban Gravity-Vacuum Transit 283

Behavioral Approaches to Modal Demand Modeling 398

Bi-Modal Urban Transportation System Study: Volume I, Final Report 358

Bi-Modal Urban Transportation System Study: Volume II, Technical Appendices 359

Bi-Modal Urban Transportation System Study: Volume III, Addendum -- Technical Appendices 360

Blue Streak Bus Rapid Transit Demonstration Project -- Phase I: Interim Report . 126

Broome County Bus Transit Study: Evaluation, Analysis, and Recommendations 213

Bus Design: Concepts and Evaluation 104

Bus Feeder Study for the Lindenwold Rapid Transit and the Camden, N.J. Metropolitan Region 245

Bus Feeder Study for the Lindenwold Rapid Transit and the Camden, N.J. Metropolitan Region -- Appendix to Report 246

Bus Priority Strategies for Downtown Washington 461

Bus Rapid Transit on Freeways Using Traffic Surveillance and Control 267

C.A.R.S. (Computer-Aided Routing System): A Prototype Dial-A-Bus System 75

Capital Flyer Bus Service Between the District of Columbia and Maryland and Virginia Counties in the Washington Metropolitan Area (Final Report) 147

Center City Transportation Project: Atlanta 296

Center City Transportation Project: Consumer Analysis Guideline 301

Center City Transportation Project: Dallas 297

Center City Transportation Project: Denver 298

Center City Transportation Project: Descriptive Summary 294

Center City Transportation Project: Financing Public Transportation 302

Center City Transportation Project: Institutional Strategies for Urban Transportation 303

Center City Transportation Project: Joint Development 304

Center City Transportation Project: Pittsburgh 299

Center City Transportation Project: Seattle 300

Center City Transportation Project: Summary Report 295

Center City Transportation Project: Urban Design Guideline 305

Center City Transportation Project: Urban Transportation Concepts 306

Center City Transportation: Summary of the National Urban Coalition Seminar in Minneapolis, Minnesota -- May 4-5, 1970 310

Central Area Systems Study (Summary Report) 189

Central Area Systems Study -- Volume I 190

Central Area Systems Study -- Volume II 191

Central Area Systems Study -- Volume III 192

Central Area Systems Study -- Volume IV 192

Charlotte-Mecklenburg Public Transportation Study: Short-Range Transit Needs -- Phase I 222

Cheapeake Mass Transportation Demonstration Project 123

Cleveland-Hopkins Airport Access Study: Data File Editing and Preliminary Analysis 271

Cleveland-Hopkins Airport Access Study: Data File Formats and Code Descriptions	271
Cleveland-Hopkins Airport Access Study: Selected Tabulations, Air Passenger Study	271
Cleveland-Hopkins Airport Access Study: Survey Procedures	269
Cleveland-Hopkins Airport Access Study: Survey Results	270
Collection and Distribution Systems -- Technical Reviews of Six Baseline Definitions	292
Columbia Transit Program -- Phase I: Concept Formation	64
Comments on Wave Compressibility and Static Compressibility on Subway Vehicle Performance -- Interim Report	39
Communications Technology for Urban Improvement	329
Commuter Railroad Service Improvements for a Metropolitan Area -- SEPACT I	109
Commuter Railroad Service in the National Capital Region	427
Commuter Transportation Problem, University of Maryland	426
Comparative Analysis of Traffic Assignment Techniques for Transportation Planning with Applications	445
Comprehensive Planning for Metropolitan Development	275
Comprehensive Planning Organization Transit Survey: San Diego County, Calif. ...	157
Computer Configurations for a Dial-A-Ride System	79
Control Considerations for Short-Headway A.C.G.V. Systems	321
Coordinated Bus-Rail Service: Rockland County, Westchester County, New York ...	138
Coordinated Transit for the San Francisco Bay Area -- Now to 1975 (Final Report)	14
Coordinated Transit for the San Francisco Bay Area -- Now to 1975 (Final Report) Appendix	15
Cost Analysis Tool for Bus Transit Systems -- Volumes I and II	105
Cost and Benefit Evaluation of the Sacramento Transit Authority -- Interim Technical Report #4	20
Crosstown Controversy: A Case Study, The	408
Crosstown Line 9: An Evaluation of a New Route -- Interim Technical Report #8 ..	24
Crosstown Line 9 Saturday Passenger Survey -- Technical Report #2	18
D.C. Transportation Controversies, Values and Integration of Communities	425
Dashaveyor Transit and Cargo Systems, A Baseline Definition	278
Data Acquisition for Vehicles in Confined Spaces (VICS-70) Facility -- Interim Report	41
Data Plotting and Analysis, Origin Destination, Technical Report #4	91
Data Requirements for Urban Location/Communications Systems	71
Demand-Actuated Road Transit (DART): Performance and Demand Estimation Analysis	103
Demographic Procedure for Bus Route Design -- Interim Technical Report #5, A ...	21
Demonstration Phase -- Mass Transportation Demonstration Grant for Employment-Facilitation Transportation Program (Final Technical Report)	28
Denver Transit Study	164
Description and Cost and Timescale Estimates for Elements of a Gravity-Vacuum Transit Demonstration (Final Report)	326
Design and Feasibility of a Mobile Overpass Road Repair Vehicle, MORV	438
Design of a Freeway Entrance Ramp Merging Control System	466
Design of Tunnel Liners and Support Systems	319

Design of Urban Transportation for the User -- Monograph #1	342
Designing Urban Transit Systems -- An Approach to the Route-Technology Selection Problem, Research Report #6	457
Developing and Testing a Behavioral Modal Split Model	404
Development and Demonstration of a Family of Practical Moving-Way Transport Systems for Pedestrians -- Monograph #13, The	353
Development and Demonstration of an Automatic Passenger Counter -- Volume I	128
Development and Demonstration of an Automatic Passenger Counter -- Volume II	128
Development of a Course of Instruction in Urban Transportation Management -- Monograph #3, The	343
Development of Basic Mathematical Models for Subway Environmental Simulation -- Interim Report	38
Dial-A-Ride: An Overview of a New Demand-Responsive Transportation System	86
Dial-A-Ride Transportation System -- Summary Report, The	87
Dial-A-Ride Vehicle Specification	81
Digital-Voice Overlay for Land Mobile Communications	72
Downtown Loop Bus Program -- Report #2	107
Dual Mode Transportation Systems -- Analysis of Demands and Benefits in Urban Areas, and Development of Performance Requirements	410
Dulles International Airport Access	417
Dynamic Direction for Vehicle Operations	69
Dynamics of a Model Vehicle Running on an Imperfect Elastic Track -- Interim Report	45
East-West Transitway Location, Milwaukee County Transit Study	243
Economic Considerations for Dial-A-Ride	76
Economic Information for Environmental Quality Management	449
Effect of Age on Urban Travel Behavior (Report #1), The	430
Effect of Edge Marking on Narrow Rural Roads	447
Effect of Reduced Fare Plans for the Elderly on Transit System Routes	332
Effect of the 1966 New York City Transit Strike on the Travel Behavior of Regular Transit Users	98
Efficient Spectrum Utilization for Automatic Vehicle Location Systems	73
Estimates of Prospective Capital Investment in Urban Public Transportation	31
Eugene-Springfield Transit Study Report	228
Evaluating the Central City Access Opportunity Provided by a Public Transportation System -- Research Report #1	434
Evaluation of Alternative Service Improvements -- Interim Report #6	205
Evaluation of Alternative Service Improvements, Proposed Routes -- Interim Report No. 6A	206
Evaluation of City Transit Bus "E.I.P." Kits to Reduce Engine Smoke, Odor, Noxious Emissions and Noise	148
Evaluation of High Speed Ground Access Between Los Angeles International Airport and the San Fernando Valley	161
Evaluation of Station Fare Collection Systems in Use at Kew Gardens and Forest Hills Stations of the Long Island Railroad	136
Evaluation Procedures for Poverty Transportation Projects -- Phase I: Summary Report	273

Evolution of Metro, The	423
Evolution of the D.C. Highway System, The	452
Experimental Bus Lines in Metropolitan Nashville	120
Factor Analysis of the Tendency of Shirley Highway Commuters Not to Ride a Transit Vehicle, A	462
Fare Structure: Design, Implementation and Evaluation -- Technical Report #2 ...	90
Fast Transit Link Systems, Technical Reviews of Four Baseline Definitions	288
Feasibility and Evaluation Study of Reserved Freeway Lanes for Buses and Car Pools	325
Feasibility of Federal Assistance for Urban Mass Transportation Operating Costs .	388
Feasibility of Moving Walks/Boston -- A: Transportation	194
Feasibility of Moving Walks/Boston -- B: Engineering	195
Feasibility of Moving Walks/Boston -- C: Design	196
Feasibility of Moving Walks/Boston -- D: Legal	197
Feasibility of Moving Walks/Boston -- Overview	193
Feasibility of Transit Service in Great Falls, Montana	210
Feasibility Study of an Integrated City and University Transportation System, (Final Report)	129
Federally Assisted Sacramento Transit Research and Improvement Project	25
Flint Transportation Authority Demonstration Project: Special Interim Report ...	92
Flywheel Energy-Storage Systems for Transit Buses -- Monograph #12	352
Freeway and Highway Traffic Noise: An Information Base for Urban Development Decisions	390
Frequency Management for Vehicle Command and Control	66
Frequency Spectrum Availability	70
Friction Braking Systems -- Report #6	6
Frontiers of Technology Study -- Volume I: Summary	373
Frontiers of Technology Study -- Volume II: Survey	374
Frontiers of Technology Study -- Volume III: Implementation Requirements Studies	375
Future Urban Transportation Systems: Descriptions, Evaluations, and Programs -- Final Report I	379
Future Urban Transportation Systems: Desired Characteristics -- Memorandum Report #1	381
Future Urban Transportation Systems: Impacts on Urban Life and Form -- Final Report II	380
Future Urban Transportation Systems: Technological Assessment -- Memorandum Report #2	382
G.V.T. 170/250 MPH Demonstrator Cost and Timescale	327
General Electric Aerial Transport System, A Baseline Definition	279
Grand River Avenue Transit Survey -- Detroit, Michigan (Final Report)	89
Gravity-Vacuum Transit System, Baseline Definition of Airport Access and Corridor Systems	284
Grouped Road Vehicles -- Monograph #8	348
Guidelines for New Systems of Urban Transportation -- Volume I: Urban Needs and Potentials	336

Guidelines for New Systems of Urban Transportation -- Volume II: A Collection of Papers	337
Guidelines for New Systems of Urban Transportation -- Volume III: Annotated Bibliography	338
Headway Sensing for Automatically Controlled and Guided Vehicles	320
Heat-Assisted Tunnel Boring Machines	324
High Speed Ground Transportation Airport Access Route Study, Los Angeles International Airport to San Fernando Valley	160
History of Transit and Innovative Systems	85
Hospital and Medical Center Express Bus Service Project -- Final Report	121
Human Sensitivity to Whole-Body Vibration in Urban Transportation Systems: A Literature Review	291
Impact of Rapid Transit: An Evaluation of the Proposed Allegheny County Transit Expressway Revenue Line, The	396
Impact of Transportation Noise on Urban Residential Property Values with Special Reference to Aircraft Noise	424
Impact on Transit Ridership and Revenue of Reduced Fares for the Elderly	393
Implementation of Transit Improvements -- Interim Report #7	207
Implementation Requirements for Four Advanced Urban Transportation Systems	376
Implications of Dial-A-Ride for the Poor	82
Improved Transit Services (Final Report)	211
Improving the San Angelo Transit System, A Recommended Program	238
Information Systems for the Urban Transportation Planning Process	443
Initial Chicago North Suburban Transit Improvement Program, 1971-1975 -- Volume I: Report and Exhibits, An	178
Initial Chicago North Suburban Transit Improvement Program, 1971-1975 -- Volume II: Technical Supplement, An	179
Integrated Island-Wide Bus System -- Summary Report, An	174
Integrated Island-Wide Bus System -- Volume I: Analysis and Recommendations, An	175
Integrated Island-Wide Bus System -- Volume II: The Transit Environment, An	176
Integrated Island-Wide Bus System -- Volume III: 1970 Bus Passenger Survey, An .	177
Interactive Editing of Transportation Networks -- Research Report #4	456
Interactive Graphic Transit Simulator, A Tool for Planning Node-Oriented Transit Systems -- Research Report #7, The	458
Interim Transit Study (Final Report)	226
Intra-Airport Transportation Systems: An Examination of Technology and Evaluation Methodology	307
Introducing Patron Opinion into Resource-Allocation for Public Transportation ...	464
Investigation of Steel Wheel-Rail Noise and Techniques for Its Suppression -- Monograph #15	354
Investigation of the Car-Following Model Using Continuous System Model Program (CSMP) Techniques, An	406
J. & L. Story -- A Manpower/Transportation Demonstration Project -- Report Number One, The	106

Job Accessibility: A Study of Factors Inhibiting Employment	216
Job Express Transportation	65
Joint Development: An Economic Input	431
K.C.I. Rapid Transitway -- Engineering Design Report Forecast of Passengers, Revenue, and Operating Costs	250
K.C.I. Rapid Transitway -- Engineering Design Report: Investigations, Pre- liminary Plans, and Project Costs	251
Laboratory Cars and Support Facilities -- Technical Report #3	3
Lancaster Mass Transit Study	230
Land Use Involving Transportation Rights-Of-Way -- Monograph #5	345
Latent Demand for Urban Transportation	383
Legal Analysis of Transportation Regulation and Innovation: The Dial-A-Ride	83
Legal and Political Aspects of Free Transit in Major Metropolitan Areas	439
Livermore-Amador Valley Transportation Needs Study	162
Long Range View of Transit in Nashville, A	233
M.A.R.T.A. Referendum and Support for Mass Transit in the Atlanta Area, The	32
Mall for Westwood Village: A Study, A	389
Mass Transit Concepts for the Tampa Bay Region: Inventory, Analysis, Objectives and Improvement Program	172
Mass Transit in the Tampa Bay Region -- Summary Report	170
Mass Transit Operations: Shreveport/Bossier City	186
Mass Transit Technical Study: Iowa City (Final Report)	184
Mass Transportation Demonstration Projects ILL-MTD-3, 4 (Final Report)	61
Mass Transportation in a Small City (Final Report)	112
Mass Transportation in Massachusetts	74
Mass Transportation Studies in Memphis -- Transit Systems' History 1956-1965	119
Mass Transportation Technical Study MASS-T9-2, Final Report, A	188
Materials Handling for Tunneling	323
Mathematical Model for Optimizing the Assignment of Man and Machine in Public Transit, A	127
Measuring Accessibility -- Progress Report I (Occasional Paper #5)	403
Merrick Minibus: A Small Feeder Bus Operation for Commuters, The	99
Methodological and Parametric Foundations for Urban Transport Technology Evalua- tion	420
Methodology for Developing Security Design Criteria for Subways, A	395
Methodology for Incorporating Community Values into Planning Goal Formulation -- Report #3	432
Methods for Evaluating Proposed Urban Location and Communications Systems	68
Methods of Improving Transportation Facilities for Inner-City Dwellers	418
Metro Flyer: A Suburban Express Bus Service to Downtown, The	63
Metro Hospital Bus Service Demonstration Project -- Report #3	108
Metro Impact in Arlington County: A Case Study and Evaluation of a Transit Growth Model	451

Metro Park-Ride Fare Collection System, A	428
Milwaukee Area Transit Plan	242
Milwaukee County Dual-Mode Systems Study -- Volume I: Summary Report	130
Milwaukee County Dual-Mode Systems Study -- Volume II: Technical Evaluation	131
Milwaukee County Dual-Mode Systems Study -- Volume III: Socio-Economic Evaluation	133
Milwaukee County Dual-Mode Systems Study -- Volume IV: Implementation Plan	134
Minibus in Washington, D.C., The	29
Minicar Transit System (Final Report)	114
Minicar Mass Transit System -- Final Report on Phase I: Feasibility Study -- Book I, Summary	115
Minicar Mass Transit System -- Final Report on Phase I: Feasibility Study -- Book II, Summary	116
Modal Choices and Travel Attributes of the Inner-City Poor	442
Model for Predicting Transit Ridership -- Interim Technical Report #7, A	23
Models of Urban Transportation -- Monograph #9	349
Modes of Transportation -- Sources of Information on Urban Transportation, Report #2	263
Monographs on Potential R.D. & D. Projects -- Study in New Systems of Urban Transportation	341
Nassau County Bus System, A Summary of Financial Aspects: Technical Report #2 ..	214
Nassau County Bus System, Prospects for Bus Transportation: Report #3	215
National Perspective on Center City Transportation: 21 Cities, A	33
National Urban Transportation Test and Evaluation Center, A	339
New Approaches to Public Transportation in the Northern Middlesex Area	198
New Haven Railroad Commuter Service	142
New Systems Implementation Study -- Volume I: Summary and Conclusions	364
New Systems Implementation Study -- Volume II: Planning and Evaluation Methods .	365
New Systems Implementation Study -- Volume III: Case Studies	366
Niagara Frontier Mass Transit Study -- Summary Report	217
Niagara Frontier Mass Transit Study -- Technical Report	218
Operating Results, 1968 -- Interim Report #3	203
Operating Strategies for Demand-Actuated ACGV Systems -- Volume I: Design and Simulation	322
Operations Analysis of Augmented-Guideway Systems -- Monograph #6	346
Owensboro Transit Study	185
P.A.T.H. Station Modification and Rehabilitation Technical Study	255
Parametric Analysis of Generic Urban Transit Systems	289
Park-And-Ride Rail Service -- Jersey Avenue Station, New Brunswick, N.J.	135
Parking and Urban Dynamics	429
Passenger Psychological Dynamics -- Sources of Information on Urban Transportation, Report #3	264

Permanence of Trip Generation Equations -- Report #6, The	460
Phoenix Urban Area Public Transportation Study	152
Physical and Geometric Data for Subway System Components	53
Pilot Specification for the Procurement of Multiple-Unit Railway Commuter Cars ..	334
Planning of Node-Oriented Transit Systems -- An Application of Man-Machine Inter- active Problem Solving, Research Report #3, The	455
Planning Urban Transportation Systems: A Model for Generating Socially Desir- able Transportation Network Configurations -- Research Report #2	435
Politics of Innovation in Urban Mass Transportation Policymaking: The New Sys- tems Example, The	421
Portland Mass Transit Study -- Phase I-A: Municipal Acquisition	229
Potential Application of the Helicopter in Urban Mass Transportation -- Mono- graph #18	356
Potential Near-Term Improvements in Urban Transportation	387
Preliminary Examination of Maxibuses, A	309
Preliminary Report on the Cleveland Before and After Study, A	272
Preliminary Steady-State Subway Aerodynamic Analysis (Incompressible) -- Interim Report	40
Preliminary Wave Analysis of Unsteady Subway Vehicle Aerodynamics	57
Proceedings of the University of Oklahoma Urban Transportation Institute -- 1970	433
Program to Establish an Urban Transportation Information and Analysis Center -- Monograph #10, A	350
Program to Evaluate Advanced Technology for Buses -- Monograph #11, A	351
Project IS: Improved Scheduling, An Investigation of the Possibility of Rein- stating Owl Service on Certain Lines of the Massachusetts Bay Transportation Authority (Final Report)	411
Projection of Urban Personal Transportation Demand	377
Proposed Method for Aerodynamic Mathematical Analyses -- Interim Report	37
Proposed Transportation Master Plan for Dade County -- A Summary	165
Prototype Suburban Transportation Centers	180
Public Attitudes Toward Transit -- Interim Report #4	204
Public Information Systems in Urban Mass Transit	441
Public Operation of Transit Services in Madison Metropolitan Area	244
Public Transportation in Metropolitan Pensacola, Florida	169
Qualitative Aspects of Urban Personal Demand	335
Queens-Long Island Traffic Demand Model, The	95
Quest for Integrated and Balanced Transportation Systems in State Government, A .	459
Radial Express and Suburban Crosstown Bus Rider (Final Report), The	139
Rapid Transit Propulsion Systems -- Report #4, Volumes I and II	4
Reduction of Robberies and Assaults of Bus Drivers -- Volume I: Summary and Conclusions	26
Regional Airport Planning: A Systematic Model (Occasional Paper #1)	436
Regional Bus Transportation in Southeastern Michigan -- Volume I: Description of Present Operations	199

<u>TITLE:</u>	<u>PAGE:</u>
Regional Coordination of Urban Transportation Functions in the Milwaukee Area ...	453
Relationship of Work Trips to Employment-Connected Social and Economic Factors, The	437
Remote Sensing: With Special Reference to Urban and Regional Transportation Management	391
Report on Mode Choice Analysis for the Baltimore Region, A	187
Report on Urban Mass Transportation in Metropolitan Mobile, Alabama, Including Valuation Supplement	149
Research Bibliography: Ventilation and Environmental Control in Subway Rapid Transit Systems	35
Research Bibliography: Ventilation and Environmental Control in Subway Rapid Transit Systems -- Phase I	52
Research Project Summaries	415
Research Requirements Survey of the Rapid Rail Industry	330
Reserved Lanes for Buses: The Shirley Highway Experiment	308
Residential Segregation, Metropolitan Decentralization and the Journey to Work (Occasional Paper #3)	401
Reston Transportation Study	240
Reverse Commute Experiment (A \$7 Million Demonstration Program), The	274
Rides, Trips, and Moves on a Bus -- Interim Technical Report #6	22
S.E.P.A.C.T. II Final Report: A Study of the 1975 Commuter Railroad System in the Southeastern Pennsylvania Metropolitan Region	110
S.E.P.A.C.T. III: Final Report -- Operation Reading	111
St. Louis Metropolitan Area -- Rapid Transit Feasibility Study Long-Range Program	247
St. Louis Metropolitan Area Rapid Transit Feasibility Study Long-Range Program, Supplemental Report	248
St. Louis Metropolitan Area Rapid Transit Feasibility Study/Phase II: Alterna- tive Transit Systems	249
San Jose-Santa Clara County Bus Study	155
Santa Clara County Transportation Planning Study -- Final Report	154
Scheduling Algorithms for a Dial-A-Ride System	78
Scherer Monobeam Suspension Concept of Mass Transportation	280
Scrip System of the D.C. Transit System: Washington, D.C., The	146
Seattle Monorail Demonstration Study	125
Selected Sources of Non-Farebox Revenue for Metro: Landover and Huntington Stations	450
Service Changes and Their Effects on Revenue, Ridership, and Riders Per Mile -- Interim Technical Report #1	17
Shuttle Bus Service, Hunters Point Avenue to Manhattan: Final Report	94
Single-Track Subway Components, Subway Environmental Project -- Interim Report: November, 1970-January, 1971	36
Single-Track Subway Environmental Simulation Model -- Phase I	50
Site Selection for a Dial-A-Bus Demonstration	84
Skokie Swift, The Commuter's Friend (Final Report)	60
Sky-Kar Transivator System: A Baseline Definition	281
Skylounge System Final Report -- Summary	16

Socioeconomic Factors Underlying Public Transit Use in the Journey to Work -- Occasional Paper #1	399
Southward Transit Area Coordination Study	181
Special Transportation Requirements in Small Cities and Towns	372
Specialized Trip Distribution Study: Metropolitan Recreation	419
Stochastic Disaggregate Mode Choice Models: A Test of Three Hypotheses	440
Study of Command and Control Systems for Urban Transportation, A	362
Study of Evolutionary Urban Transportation -- Volume I	384
Study of Evolutionary Urban Transportation -- Volume II: Appendices 1, 2, 3	385
Study of Evolutionary Urban Transportation -- Volume III: Appendix 4	386
Study of Internal Circulation Systems for the Post Oak Urban Center, Houston, Texas, A	122
Study of Technical and Cost Questions Related to the Feasibility of the Gravity- Vacuum Transit System	328
Study of the Public Transit System Operating in the Little Rock/North Little Rock Area, A	153
Study of Transit: Rock Hill, South Carolina, A	231
Suburban Service Adjustment Experiment	137
Subway Environmental Design Criteria	51
Subway Environmental Survey: Chicago Transit Authority System	34
Subway Environmental Survey: Cleveland Transit System	55
Subway Environmental Survey: Massachusetts Bay Transportation Authority	49
Subway Environmental Survey: Montreal Urban Community Transit Commission	56
Subway Environmental Survey: Port Authority Transit Corporation	54
Subway Environmental Survey: Southeastern Pennsylvania Transportation Authority	46
Subway Environmental Survey: Toronto Transit Commission	47
Summary -- Report #12	12
Supplemental Studies of Urban Transportation Systems Analysis	371
Survey of Electronic Command and Control Systems	363
Survey of Propulsion Systems for Low-Emission Urban Vehicles, A	311
Survey to Evaluate the Criteria Which Influence the Purchase and Use of a Monthly Transit Pass and to Determine Reasons Why Transit Non-Pass Riders Do Not Pur- chase a Pass	140
System to Facilitate Bus Rapid Transit on Urban Freeways: The Technical Feasi- bility of Using Traffic Surveillance and Control Techniques, A	266
System to Facilitate Bus Rapid Transit on Urban Freeways: The Technical Feasi- bility of Using Traffic Surveillance and Control Techniques -- Appendices, A	268
Systems Analysis of Transit Routes and Schedules, A	145
Systems Analysis of Urban Transportation -- Volume I: Summary	367
Systems Analysis of Urban Transportation -- Volume II: Cases for Study	368
Systems Analysis of Urban Transportation -- Volume III: Network Flow Analyses ..	369
Systems Analysis of Urban Transportation -- Volume IV: Supporting Analyses	370
Systems Study of Soft Ground Tunneling, A	313
Tampa Bay Mass Transit: Planning for Tomorrow	171
Technical Evaluation of Advanced Urban Transportation Systems, Summary Report ...	293
Technical Study of Mass Transit Facilities in Mahoning and Trumbull Counties	227

Terminal Facilities Master Plan	166
Test Instrumentation -- Report #10	10
Test of Turbo-Electric Rail Car -- A Summary Report on Part Two of the Mass Transportation Demonstration Grant Project	144
Theoretical Scaling Laws for Subway Modeling -- Interim Report	42
Toledo Transit Analysis	224
Topics in the Design of Dial-A-Ride Demonstration Experiments	77
Town Flyer Shuttle Bus Service: A Central City Park-And-Ride Shuttle Bus Service for Commuters, The	59
Track-Sharing for Urban Transportation	102
Traffic Demand Analysis for the Proposed Visitor Center/Transportation Center/ Arena Complex, Union Station Site, Washington, D.C., A	446
Transit Access to Oakland International Airport	159
Transit Development Plan and Program	158
Transit Development Program for Lee County, Mississippi, A	208
Transit Development Program for Spokane, A	241
Transit Facilities and Operations -- Volume 1: Maintenance Facilities	219
Transit Facilities and Operations -- Volume 2: Routes and Service	220
Transit Facilities and Operations -- Volume 3: Transportation Center	221
Transit Improvement Plan	253
Transit Improvement Plan: Cost Estimates and Site Selection	254
Transit Improvement Program for Burlington, Iowa 1971-1975	183
Transit Improvement Program for the Utah Transit Authority, A	239
Transit in Atlantic County	212
Transit in South Broward County	168
Transit Information Aids (Final Report)	141
Transit Planning Study: City of Mountain View	156
Transit Rider -- 1968: Interim Report #1, The	200
Transit Routes 1985: Interim Report #4	167
Transit Services: 1968 Appendix -- Interim Report 2a	202
Transit Services: 1968 -- Interim Report #2	201
Transit System in Crisis, A Case Study of D.C. Transit, A	463
Transit Technical Study -- Mississippi Coast Transportation Authority	209
Transit Technical Study, South Bend-Mishawaka Area	182
Transit Usage Forecasting Techniques, A Review and New Directions	357
Transit Vehicle Truck Concepts -- Report #5	5
Transportation and Central City Unemployment	93
Transportation Effects on the National Alliance of Businessmen Program	30
Transportation-Employment Project -- A Research Project to Determine and Test the Relationship Between a Public Transportation System and Job and Other Opportunities of Low Income Groups (Final Report)	27
Transportation Innovation and Changing Spatial Patterns: Pittsburgh, 1850-1910 .	397
Transportation Networks as a New Urban Space Partition	407
Transportation Planning in the Central Business District	234
Transportation Requirements and Effects of New Communities	378
Transportation Study -- A Part of the Mass Transportation Program for East Liver- pool and Environs	225
Transportation System Candidates for Urban Applications	312

Transportation Technology Distribution System for a High Density Urban Area, A Baseline Definition	282
Travel Patterns of Persons Residing in High-Density Urban Areas, The	465
Tri-City Transportation Needs Study -- Summary and Conclusions Re: Alternative Plans; Interpretation of Household Survey; and Tri-City-Hayward Service Co- ordination	163
Trip to Work: A Submodule of a General Metropolitan-Regional Area Man-Machine Simulation, The	422
Tube Vehicle Systems: Aerodynamic Characteristics	394
Turbo-Electric Rail Car: Technical Report, The	143
Two-Way Radio Communication Mass Transportation Demonstration Project	97
Unconventional Heat Engines for Urban Vehicles -- Monograph #16	355
Urban Frontier -- Occasional Paper #4, The	402
Urban Goods-Movement Demand	340
Urban Gravity-Vacuum Transit System: Mark 3B and Mark 4B Baseline Definitions ..	285
Urban Mass Transit Game (Maintenance) -- Technical Report, Phase IA: Instructions for Participants, The	124
Urban Mass Transit Game (Maintenance) -- Technical Report, Phase IB: Administra- tive Manual, The	124
Urban Mass Transit Planning Project -- Technical Report #1: Factors Influencing Transit Planning	262
Urban Mass Transit Planning Project -- Technical Report #2: Computer Program Specifications	256
Urban Mass Transit Planning Project -- Technical Report #3, Volume I: IBM 7090/ 94 Computer Programs General Information Manual	257
Urban Mass Transit Planning Project -- Technical Report #3, Volume II: IBM 7090/ 94 Computer Programs Users' Reference Manual	257
Urban Mass Transit Planning Project -- Technical Report #4: Modal Split Simula- tion Model	258
Urban Mass Transit Planning Project -- Technical Report #5: Recommendations for Urban Mass Transportation Research	259
Urban Mass Transit Planning Project -- Technical Report #6, Volume I: IBM Sys- tem/360 Computer Programs General Information Manual	260
Urban Mass Transit Planning Project -- Technical Report #6, Volume II: IBM Sys- tem/360 Computer Programs Users' Reference Manual	261
Urban Mass Transit Study for the City of Brownsville, Texas, An	237
Urban Mass Transportation Demonstration Project MASS-MTD-6 (Final Report)	88
Urban Streets and Their Environments -- Monograph #7	347
Urban Transportation Decision-Making -- 1: Political Processes of Urban Freeway Controversies	412
Urban Transportation Decision-Making -- 2: Houston, A Case Study	414
Urban Transportation Decision-Making -- 3: San Francisco, A Case Study	413
Urban Transportation Planning -- Sources of Information on Urban Transportation, Report #4	265
Urban Transportation Policy: Fact or Fiction? Occasional Paper #2	400
Use of Digital Computers in the Economic Scheduling for Both Man and Machine in Public Transportation	62

V.I.P. Transportation -- Extending Urban Mass Transportation in a Typical Small City (Final Report) 96

Value of Speed in Public Transit Services 409

Varo Monocab System, A Baseline Definition, The 286

Vehicle Communications for a Dial-A-Ride System 80

Vehicles in Confined Spaces (VICS-120) Facility Design -- Interim Report 48

Vent and Station Test (VST) Facility Design -- Interim Report 44

Vent and Station Test (VST) Facility -- Station Testing 58

Views and Values of the Community Effected by a Major Transportation Project, The 454

W.M.A. Transit Company 416

Waco Transit Study 236

Washington Metropolitan Area Rail Commuter Feasibility Study 333

Westinghouse Vehicle System for Major Activity Centers: A Baseline System Definition, A 287

Who Rides the Bus? Passenger Characteristics and Riding Patterns of the Sacramento Transit Authority (Interim Technical Report #3) 19

Wichita Falls Transit Study 235

Winston-Salem Transit Study 223

AUTHOR INDEX

Entries in this two-part index are listed alphabetically. Part I lists individual names of authors; Part II lists organizations. In most cases where an abstract is entered under the name of an individual author, it also appears under the organization for which the author prepared the report. Entries listed under organizations also include reports which did not cite an individual author.

Users should note that author citations refer only to the specific preparer of a given report, and that organizational references frequently include contractors who were not the actual, direct recipients of UMTA project grants. Multiple authors are entered only under the first name cited.

AUTHOR INDEX

Part I: Individual Names

	<u>PAGE:</u>
Alexander, D.E.	125
Allen, W. Bruce, <u>et. al.</u>	404
Artabane, Joseph A. and Francis J. Nealon	463
Ashford, Norman and Frank M. Holloway	430, 460
Aten, Beach W. and Gary F. Bulmash	416
Bailey, Richard F., <u>et. al.</u>	465
Barden, Robert and John H. Thompson	402
Barnes, Carole Wolff	17, 19, 21, 25
Barnes, Carole Wolff, <u>et. al.</u>	24
Baum, Milton S., <u>et. al.</u>	20
Baxter, Robert G.	417
Beier, Frederick J.	444
Bevans, Patrick, <u>et. al.</u>	79
Blevins, R.W. (ed.)	288
Bowman, R.D. (ed.)	433
Boyce, David E. and B.V.A. Murthy	405
Brand, Daniel	410
Brandon, James G. and Merle Coon	432
Bruck, Henry, <u>et. al.</u>	77
Cannon, Mark W.	32
Cantilli, Edmund J., <u>et. al.</u>	464
Carstens, J.P., <u>et. al.</u>	324
Causey, James W.	445
Cheaney, E.S. and J.T. Herridge	339
Cheaney, E.S. and C.W. Vigrass	351
Choksi, Niranjana S. and Edmund C. Feldy	438
Colcord, Frank C., Jr.	413, 414
Cooper, Ernest	418
Crain, John L.	30, 273, 274
Deere, D.U., <u>et. al.</u>	319
Demetsky, Michael J.	398
Dillon, Robert W. and John A. Bailey	439
Dueker, Kenneth J. and Frank E. Horton	443
Dueker, Kenneth J. and James Stoner	184
Duncan, J.M., <u>et. al.</u>	323

Edwards, L.K. and Bruce E. Skov	283, 327
Ehrlich, Theodore	419
Eisenberg, Lawrence and Edward Kaplan	406
Elias, Samy E.G.	62, 127, 129
Elias, Samy E.G. and Nelson S. Smith	128
England, Carl R., Jr.	333
Enright, J.J.	354
Falocchio, John, <u>et. al.</u>	442
Ford, B.M., <u>et. al.</u>	289
Fraize, W.E. and R.K. Lay	311
Freck, P.G., <u>et. al.</u>	307
Gebhard, J.W.	290
Geiser, Kenneth R., Jr.	412
Genis, Thomas P.	446
Glennon, John C. and Vergil G. Stover	266, 268
Gouse, S. William, Jr. and Ezzat I. Wali	394
Graham, Philip A.	420
Graves, Frank M. and Ralph E. Rechel	31
Greytak, David	401
Gurin, Douglas and John Wofford	82
Gutowsky, A.R.	18, 23
Handman, A.L., <u>et. al.</u>	312
Hanes, R.M.	291
Harris, Oscar L., Jr.	395
Hassan, Zuhair Y.	447
Hines, J. Michael and David W. Sloan	83
Hinman, E.J., <u>et. al.</u>	292, 321
Hitt, William D.	343
Hoess, J.A.	355
Jones, David L.	462
Kalachek, Edward D. and John M. Goering	93
Kasoff, Mark J.	399
Klee, Harold J.	466
Koike, Hirotaka	435
Lambert, John O.	13
Lane, Samuel R.	390

Langfeld, Stanley	448
Lavender, John O. and Peter L. Stopher	440
Lawrence, David G.	421
Leis, R.D.	353
LeRicolais, Robert G. and Alexander Messinger	407
Liff, Sally D. and Richard M. Michaels	441
Lobdell, Norman E.	344-349
Loomis, J.P.	356
Makofski, R.A. (ed.)	293
Manarolla, Jerre A.	422
Margolis, Howard	309
McGean, Thomas J.	330
Mertins, Herman, Jr. and David R. Miller	400
Milbanks, Thomas J.	403
Mittelbach, Frank G. and Michael I. Schneider	391
Morlok, Edward K., <u>et. al.</u>	332
Mouchahoir, George E.	437
Murin, William J.	423
Paik, Inja K.	424, 429
Pappas, George T.	450
Parente, Francis R.	425
Parker, Elizabeth	310
Prangley, Robert E.	426
Pratt, Richard H. and Howard W. Bevis	178, 179
Rapp, Mattias H.	455, 456
Rapp, Mattias H., <u>et. al.</u>	458
Rasmussen, David W.	431
Rea, John C.	457
Reiner, Thomas A., <u>et. al.</u>	408
Roddin, Marc	411
Roesler, W.J., <u>et. al.</u>	322
Roos, Daniel and Edwin H. Porter	88
Roos, Daniel, <u>et. al.</u>	87
Rosinger, George, <u>et. al.</u>	342
Roszner, Ervin S. and Lester A. Hoel	393
Roszner, Ervin S., <u>et. al.</u>	396
Roth, S.H.	331
RuBino, Richard G.	359
Ryan, Charles R.	454
Scales, W.C.	72
Scales, W.C. and John G. Barnby	73

Schenker, Eric and L.R. Fogel	453
Segal, Murray D.	194
Shinn, Richard	436
Skov, Bruce E.	328
Smith, Arthur J.	427, 461
Solomon, Richard J. and Arthur Saltzman	85
Stafford, Joseph, <u>et. al.</u>	76
Stover, Vergil G. and J.D. Benson	236
Stover, Vergil G. and John C. Glennon	267
Stuart, Henry L.	173
Studholme, Edward D.	428, 451
Suomala, John B.	81
Sweek, John E.	434
Swetnam, G.F. and F.I. Willingham	148
Tarr, Joel A.	397
Taylor, Jean G.	308
Tomlinson, Graham	22
Tuzo, Gerald C.	452
Vigrass, J. William	350
Vincent, Burnell W.	429
Vuchic, Vukan R., <u>et. al.</u>	114, 409
Ward, John E. and Robert G. Rausch	80
Weinrich, John E. and Robert L. Gray	213
Wiggers, George F.	272
Wilcox, J.P.	352
Wilson, Nigel H.M., <u>et. al.</u>	78

Part II: Organizations

PAGE:

A.B.T. Associates, Inc.	335
Aerial Transit Systems, Inc.	276
Alden Self-Transit Systems Corporation	277
Allis-Chalmers Corporation	130-134
American Academy of Transportation	90-92
Architects Collaborative, Inc., The	196
Atlanta, City of, Department of Planning	59
Baltimore, City of, Department of Transit and Traffic	65
Barton-Aschman Associates, Inc.	242-243, 336-338
Battelle Memorial Institute	339-356
Bendix Aerospace Systems Division	320
Bingham, Colonel S.H., Associates, Inc.	192
Boston Redevelopment Authority, The	193
California Institute of Technology	39-42, 48, 57
California, State of, Business and Transportation Agency	27
California, University of, at Los Angeles	389-391
Carnegie Mellon University, Transportation Research Institute .	383, 392-398
Center for Transportation Studies	105
Chicago Transit Authority, Research and Planning Department ...	60
Cleveland Transportation Action Program	106-108
Columbia Park and Recreation Association of Columbia, Maryland	64
Comprehensive Planning Organization, County of San Diego	157
Consad Research Corporation	357
Consortium of Universities, Urban Transportation Center (Wash- ington, D.C.)	415-429, 445-452, 461- 463
Cornell Aeronautical Laboratory of Cornell University	358-360
Coverdale & Colpitts	149, 169, 199
Dashaveyor Company, The	278
Day & Zimmerman, Inc.	387
DeLeuw, Cather & Company	34, 46, 47, 49, 54-56, 136, 152, 156, 162, 163, 186, 191, 192
Detroit, City of, Department of Street Railways	89
Developmental Sciences, Inc., Aerospace Technology Division ...	43-45, 58
District of Columbia, Government of, and the Washington Met- ropolitan Area Transit Commission	29

Economics Research Associates and Alan M. Voorhees & Associates, Inc.	238
Edmundson, Kochendoerfer, Kennedy/Daniel, Mann, Johnson & Mendenhall	229
Ely, Bartlett, Brown & Proctor	197
Fenix & Scisson, Inc. and Arthur D. Little, Inc.	313
Florida State University, Transportation Center	430-432, 459, 460
General Electric Company	361-363
General Electric Co., Research and Development Center	100
General Electric Co., Transit Systems Department	279
General Motors Research Laboratories	364-366
General Research Corporation	367-371
Georgia Institute of Technology	437
Gilman, W.C., and Company, Inc.	139, 140, 164, 182, 183, 224
Gilman, W.C., and Company, Inc., T.E.I. Consulting Engineers, and Wilbur Smith & Associates	218
Hempstead, Town of, New York	99
Hill, Carroll V., and Associates	225
Holmes & Narver, Inc.	323
Howard, Needles, Tammen, and Bergendorff	250, 251
I.I.T. Research Institute	66-73
Illinois Institute of Technology, Institute of Design	438
Illinois, State of, Department of Public Works and Buildings ...	181
Illinois, University of, Bureau of Economic and Business Research	61
Illinois, University of, Department of Civil Engineering	319
Institute for Defense Analysis	307-310
Institute of Public Administration	31, 32, 102
Institute of Public Administration and Teknekron, Inc.	103
Iowa, University of	443
Iowa, University of, Institute of Urban and Regional Research ..	184
Johns Hopkins University, Applied Physics Laboratory	288-293, 321, 322
Journal of Urban Transportation Corporation	263-265
Kaiser Engineers	35, 36, 51-53, 159, 160
Kansas City Area Transportation Authority	252-254

Kansas State University, Kansas Engineering Experimental Station	62
Kimley-Horn & Associates, Inc.	168
Klauder, Louis T., and Associates	143
Lawrence, City of, City Planning Commission	188
Little, Arthur D., Inc.	301, 302
Little, Arthur D., Inc., <u>et. al.</u>	294-300
Mass Transportation Commission Staff, <u>et. al.</u>	74
Massachusetts Bay Transportation Authority	189, 190
Massachusetts Institute of Technology, Urban Systems Laboratory	75-88, 410-414
Memphis Transit Authority	119
Metropolitan Atlanta Rapid Transit Authority	173
Metropolitan Dade County Planning Department	165, 166
Metropolitan Planning Commission, Nashville, Tennessee	120
Metropolitan Transit Authority, Nashville, Tennessee	121
Metropolitan Transit Authority of Maryland	63
Meyers Electro/Cooling Products, Inc., Systems Research Division	28
Midwest Research Institute	372
Minnesota, University of	444
Mitre Corporation, The	148, 311, 312, 330, 331
Montgomery and Greene County Transportation and Development Planning Program	226
Nassau County Planning Commission	214, 215
National Academy of Engineering, Committee on Telecommunications	329
National Urban Coalition, The	33
New Castle Area Transit Authority, The	112
New York City Transit Authority	97, 98
New York, State University of, at Binghamton	213
Niagara Frontier Transportation Authority	217
North American Rockwell, Los Angeles Division	373-376
Northeastern Illinois Planning Commission	180
Northern Middlesex Area Commission	198
Northwestern University, Transportation Center	332, 439-441
Oklahoma, University of, Urban Transportation Institute	433

Parsons Brinckerhoff, Quade & Douglas	37, 38, 50
Parsons Brinckerhoff-Tudor-Bechtel	1-12
Parsons Brinckerhoff-Tudor-Bechtel-Sverdrup & Parcel	247-249
Peat, Marwick, Livingston & Company	95, 377
Peat, Marwick, Mitchell & Company and the Metropolitan Wash- ington Council of Governments	318
Pennsylvania, University of	115, 116
Pennsylvania, University of, Center for Research and Experiment	114
Pennsylvania, University of, Transportation Studies Center	404-409
Peterson, W.M., Consulting Engineers	237
Pinnell-Anderson-Wilshire & Associates	235
Polytechnic Institute of Brooklyn	442, 464-466
Port Authority of Allegheny County, Pennsylvania	113
Port Authority Trans-Hudson Corporation	255
Port of Oakland	13
Praeger-Kavanagh-Waterbury, Engineers	245, 246
Public Research and Management, Inc.	231
Pullman, Inc., Pullman-Standard Division	334
Real Estate Research Corporation	303, 304
Regional Economic Development Institute	378
Regional Planning Commission, Cuyahoga County, Ohio	269-271
Rensselaer Research Corporation	104
Rhode Island Public Transit Authority	118
Rome, City of, New York	96
Sacramento State College	17-25
Santa Clara, County of, Transportation Policy Committee	154
Scherer Monobeam Company	280
Simpson & Curtin, Transportation Engineers	14, 15, 117, 167 200-207, 210-212, 219-221, 244
Skidmore, Owings & Merrill	305
Sky-Kar Corporation	281
Smith, Wilbur, and Associates	94, 123, 155, 185, 209, 222, 223, 230 306
Snavely, King & Tucker, Inc.	153
Southeastern Pennsylvania Transportation Authority	109-111
Sperry Rand Corporation, Sperry Systems Management Division	314-317
Stanford Research Institute	30, 273, 274, 379- 382
Stanford Research Institute and University of California	26
Stone & Webster Management Consultants, Inc.	227
Syracuse-Onondaga County Planning Agency	216
Syracuse University Research Corporation	326

Syracuse University, Urban Transportation Institute	399-403
System Development Corporation, <u>et. al.</u>	16
Systems Analysis and Research Corporation	161
T.R.W. Systems, Inc.	171
Tampa Bay Regional Planning Council	170, 172
Texas A&M University, Texas Transportation Institute	236
Texas Transportation Institute	266-268
Transportation Technology, Inc.	282
Tri-State Regional Planning Commission	144
Tri-State Transportation Commission	135, 137, 138, 142
Tube Transit Corporation	283-285, 327, 328
Tucson Area Transportation Planning Agency	150, 151
United Aircraft Research Laboratories	324
United Engineers and Constructors, Inc., Jackson and Moreland Division	195
United States Department of Transportation	272
United States Department of Transportation, Urban Mass Trans- portation Administration	388
Urban Design and Development Corporation	122
Varo, Inc., Transportation Systems Division	286
Virginia Polytechnic Institute, Department of Industrial Engineering	124
Voorhees, Alan M., and Associates, Inc.	126, 145, 158, 174- 177, 187, 208, 228, 232-234, 239-241, 256-262
Voorhees, Alan M., and Associates, Inc., <u>et. al.</u>	325
Washington Center for Metropolitan Studies	275
Washington Metropolitan Area Transit Commission	141, 146
Washington Metropolitan Council of Governments	147
Washington University (St. Louis)	93
Washington, University of (Seattle)	125, 434-436, 455-458
West Virginia University	127-129
Westinghouse Air Brake Company, <u>et. al.</u>	384-386
Westinghouse Electric Corporation, Transportation Division	101, 278
Wisconsin, University of, at Milwaukee	453, 454

KEY WORD SUBJECT INDEX

A major effort in the preparation of this volume was the development of a List of Key Word Subject Headings. This list is the first of its kind developed exclusively to reflect the subject content of UMTA project reports. The list contains 252 actual keywords which have been CAPITALIZED AND UNDERLINED for easy identification. The list also contains numerous "directors" which cross-reference users to the appropriate keywords. Directors are always followed by the word: "see"

In the preparation of each abstract, up to 12 keywords were selected to identify major topical areas covered in the corresponding report. In the following index, each Key Word is followed by the page numbers of all abstracts which contain that Key Word. Thus the 13 numbers which follow the Key Word "ACCESS, PLANNING AND CONTROL" represent the pages on which relevant reports are abstracted.

KEY WORD SUBJECT INDEX

A.C. Motors: see Propulsion Systems, electric

Acceleration: see Speed and Speed Control

Access, opportunities: see Time Costs

ACCESS, PLANNING AND CONTROL

pp. 95, 167, 193, 194, 251, 268, 269, 310, 353, 403, 407, 417, 466

Access, roads: see Highway, types

Accidents: see Safety

Acoustics: see Noise and Noise Control

Acquisition: see Public Ownership

Acquisition, land: see Land, acquisition

Activity Center: see Center City

Adhesion: see Wheels; see Tracks and Trackage; see Brakes and Braking, inclusive

Adjacent Property: see Land Use

Administration: see Management, inclusive; see Government, inclusive

ADVERTISING AND PROMOTION

pp. 18, 25, 32, 59-61, 65, 96, 99, 109-111, 113, 118, 139, 146, 147, 149, 169, 173,
174, 184, 186, 222, 238, 259, 296, 383, 412, 416, 450

AERODYNAMICS

pp. 13, 35-44, 47, 48, 50, 52-54, 57, 58, 288, 382

AERIAL STRUCTURES

pp. 8, 11, 12, 276, 279, 280, 287, 288, 382

AGE: see also Elderly; see also Youth

pp. 22, 23, 200, 222, 238, 430

AIR CONDITIONING

pp. 34, 47, 49-51, 56, 81, 100, 101, 328

AIR CUSHION VEHICLE

pp. 13, 160, 282, 292, 373

Air Flow: see Aerodynamics

AIR POLLUTION: see also Environment and Environmental Control

pp. 20, 29, 51, 54, 114, 148, 241, 311, 329, 352, 355, 358, 374, 375, 431, 449

AIRCRAFT, TRAFFIC CONTROL

pp. 165, 356

AIRCRAFT, V.T.O.L.

pp. 16, 356, 373, 382

AIRPORT, ACCESS

pp. 13, 16, 55, 159-161, 192, 250, 269-272, 276, 279, 285, 287, 318, 376, 417

AIRPORT, PLANNING AND OPERATION

pp. 16, 165, 269, 307, 318, 417, 436

Alden Capsule Transit System: see People Movers, Alden StaRRcar

ALGORITHMS

pp. 167, 256, 314, 315, 322, 434, 456

Allocations and Allocation Models: see Budgets and Budget Planning

Alternating Current Motors: see Propulsion Systems, electric

Aluminum: see Rail, materials

Analog Systems: see Computer, programming

Anti-Pollution Devices: see Air Pollution; see Environment and Environmental Control

Articulated Bus: see Bus, design

Attitudes of Passengers: see Ridership; see Surveys

Auto Intercept: see Private Transportation, automobile; see Bus, commuter

Automatic Headway Sensing: see Headways; see Sensors

Automatic Vehicle Monitoring: see Vehicle, monitoring

Automobiles: see Private Transportation, automobile

BATTERIES AND CELLS

pp. 311, 352, 374, 375, 382

BAY AREA RAPID TRANSIT (B.A.R.T.)

pp. 1-12, 14, 15, 159, 162, 413

Beds: see Roadbeds

Behavior Patterns: see Ridership, profiles; see Modal Split

Belt Conveyors: see Conveyors

BENEFIT-COST ANALYSIS

pp. 20, 25, 26, 105, 120, 133, 142, 162, 163, 175, 205, 211, 273, 274, 313, 325,
357, 360, 364, 365, 367, 369, 370, 376, 393, 396, 408-411, 420, 431, 435, 464

BI-MODAL SYSTEMS: see also Interfaces; see also Dual Mode Systems

pp. 181, 230, 312, 358-360

BIBLIOGRAPHIES

pp. 35, 52, 263, 265, 291, 338, 350, 415

Bond Issues: see Financing Mass Transportation, sources; see Government, urban

BORING AND BORING MACHINES: see also Tunnels and Tunneling

pp. 319, 323, 324

BRAKES AND BRAKING

pp. 4, 6, 9, 81, 279, 311, 334, 354, 374, 375

BRAKES AND BRAKING, DYNAMIC

pp. 5, 101

BRAKES AND BRAKING, FRICTION

pp. 5, 12

BRAKES AND BRAKING, REGENERATIVE

pp. 101, 352

Bridges: see Overpasses

BUDGETS AND BUDGET PLANNING

pp. 14, 94, 189, 235, 250, 302, 303, 327, 375, 459, 464

BUS

pp. 74, 208, 263

Bus, articulated: see Bus, design

BUS, BUSWAY: see also Guideways

pp. 31, 64, 165, 217, 233, 242, 251, 268, 297, 308

BUS, COMMUTER

pp. 24, 28, 59, 61, 76, 90, 92, 93, 98, 99, 118, 126, 147, 155, 162, 177-180, 200,
232, 239, 240, 296, 308, 426, 433, 462

Bus, computer routing: see Computer, applications; see Routes and Routing

Bus, computer scheduling: see Computer, applications; see Schedules and Scheduling

BUS, COST

pp. 76, 87, 103-106, 120, 1-3, 153, 155, 156, 158, 163, 169, 172, 185, 186, 198, 199, 203, 205, 214, 220, 225, 226, 229, 232, 239, 246, 250, 253, 266, 309, 348, 351, 416, 463

Bus, crime: see Crime and Crime Prevention

Bus, demand-responsive: see Demand-Responsive Systems, inclusive

BUS, DESIGN: see also Vehicle, design

pp. 22, 81, 96, 104, 105, 148, 233, 309, 311, 342, 348, 351, 357, 376

Bus, Dial-A-Bus: see Demand-Responsive Systems, Dial-A-Ride

BUS, DRIVER

pp. 26, 69, 92, 146

Bus, exhaust control: see Air Pollution

BUS, EXPRESS: see also Bus, priorities

pp. 63, 65, 118-121, 123, 126, 139, 158, 162, 165, 233, 240, 267, 296, 309, 462

Bus, fares: see Fares, inclusive

BUS, FEEDER: see also Bi-Modal Systems

pp. 24, 60, 94, 99, 112, 123, 138, 167, 184, 245, 246, 248, 249, 251, 299

Bus, information: see Information Aids

BUS, INTERCITY

pp. 155, 162, 166, 170, 178, 198, 206, 209, 221

BUS, INTRACITY

pp. 27, 61, 69, 85, 92, 153, 154, 156, 169, 172, 174-176, 178, 182, 184-186, 188, 201, 202, 204-206, 210, 212, 222, 224, 225, 231-233, 235, 236, 240, 253, 310

BUS, JITNEY

pp. 85, 212

Bus, lanes: see Bus, priorities; see Lane, reserved

Bus, maintenance: see Maintenance, inclusive

Bus, management: see Management, inclusive

BUS, MINIBUS

pp. 29, 99, 105, 298

BUS, PRIORITIES: see also Lane, reserved
pp. 117, 126, 158, 205, 213, 222, 259, 266, 308, 315-317, 325, 361, 362, 461, 462

Bus, private: see Private Transportation, bus

Bus, propulsion: see Propulsion Systems, inclusive

BUS, RAPID TRANSIT

pp. 49, 130, 133, 147, 158, 242, 249, 267, 268, 310

Bus, routes: see Routes and Routing

Bus, run-cutting: see Schedules and Scheduling; see Manpower and Personnel

Bus, schedules: see Schedules and Scheduling

BUS, SCHOOL BUS

pp. 155, 198, 225, 227, 253, 259, 302

Bus, scrip: see Fare, collection

BUS, SHUTTLE: see also Bus, jitney

pp. 59, 296

Bus, Skylounge: see Aircraft, V.T.O.L.

BUS, STATIONS AND SHELTERS

pp. 166, 180, 207, 215, 221, 228, 231, 232, 237, 241, 266, 297, 357

BUS, TRANSFERS: see also Fare, inclusive; see also Trip Generation

pp. 18, 158, 175, 222, 232

Busway: see Bus, busway

Business Districts: see Center City; see Suburbs, business districts

C.A.R.S. (Computer-Aided Routing System): see Demand-Responsive Systems

Cabs: see Private Transportation, taxicabs

Capital Formation: see Financing Mass Transportation, sources

Captive Riders: see specific groups [eg. Poverty, Elderly, Handicapped]; see Ridership, profiles

Car Pools: see Private Transportation, car pools

Carbon Dioxide/Monoxide: see Air Pollution

Cargo Vehicles and Cargo Handling: see Freight Movement

Cars: see Private Transportation, automobiles

Carveyor: see People Movers, Carveyor

Catalytic Muffler: see Mufflers

Cells: see Batteries and Cells

Cement: see Highway, surfaces; see Construction, materials; see Rail, materials

Census: see Demography

CENTER CITY

pp. 33, 59, 63, 102, 107, 116, 121, 122, 129, 135, 139, 147, 181, 193-195, 200, 210, 216, 222, 234, 243, 270, 285, 294-306, 310, 335, 345, 358, 360, 381, 397, 410, 402, 427, 439, 452, 461

Central Business District: see Center City; see Suburbs, business districts

Central City: see Center City

Citizen Participation: see Community Response

City Government: see Government, urban

City Planning: see Urban Development, planning

Circulation Systems, environmental: see Air Conditioning; see Heating

Circulation Systems, vehicular: see Distribution Systems

CODES AND CODING: see also Computer, programming

pp. 67, 257, 271, 456

Collection and Distribution Systems: see Distribution Systems

Collection of Fares: see Fare, collection

Comfort: see Vehicle, design; see Environment and Environmental Control

Command and Control: see Communications

Commercial Vehicles: see Freight Movement; see Trucks and Truck Lines

COMMUNICATIONS

pp. 66-73, 75, 78, 80, 97, 116, 190, 192, 228, 292, 293, 314, 315, 317, 321, 326, 329, 331, 351, 362, 363, 384, 395, 418

Community Development: see Urban Development, inclusive

Community Planning: see Urban Development, planning

Community Relations: see Public Relations

COMMUNITY RESPONSE

pp. 25, 27, 32, 82, 89, 96, 99, 136, 137, 146, 153, 163, 173, 204, 235, 264, 301,
357, 364, 366, 396, 408, 412-414, 425, 432, 436, 444, 448, 453, 454, 464

Commuter Bus: see Bus, commuter

Commuter Railroad: see Rail, commuter

COMPUTER, APPLICATIONS

pp. 1, 2, 4, 6, 9, 38, 50, 61, 62, 71, 75, 78-80, 86-88, 100, 105, 113, 114, 124,
127, 128, 145, 243, 256-258, 260-262, 265, 278, 281, 282, 314, 315, 318-322,
338, 340, 363, 364, 368, 369, 374, 406, 422, 455-458

COMPUTER, PROGRAMMING

pp. 2, 6, 50, 61, 62, 75, 78-80, 87, 88, 124, 127, 128, 145, 177, 243, 256, 257,
262, 271, 281, 287, 315-318, 322, 332, 340, 375, 406, 455-457

Concrete: see Highway, surfaces; see Construction, materials; see Rail, materials

Condemnation: see Urban Development, renewal

Congestion: see Traffic, congestion

Consolidation: see Public Ownership

CONSTRUCTION, CONTRACTS

pp. 164, 317, 334

CONSTRUCTION, COST

pp. 218, 243, 248, 251, 254, 266, 276, 313, 324, 328, 423

CONSTRUCTION, MATERIALS

pp. 8, 11, 48, 160, 251, 313, 319

Consumer Surveys: see Surveys; see Ridership, profiles; see Market Research

Contact Rail: see Tracks and Trackage

Contracts and Contractors: see Construction, contracts

Controlled Access: see Access, planning and control

Conversion Devices: see Instrumentation; see Propulsion Systems, inclusive

CONVEYORS

pp. 193-196, 353, 379, 386

COOLING SYSTEMS: see also Air Conditioning

p. 100

Copper: see Rail, materials

Core City: see Center City

Core Drilling: see Boring and Boring Machines

CORRIDORS

pp. 15, 159, 218, 233, 240, 274, 284, 305, 361, 433, 451, 452

Cost Allocations: see Budgets and Budget Planning

Cost-Effectiveness Analysis: see Benefit-Cost Analysis

Counties and County Government: see Government, county

Counts and Counters: see Passenger Counters

CRIME AND CRIME PREVENTION

pp. 26, 69, 97, 136, 146, 329, 330, 395

Crossings: see Intersections and Crossings

Curricula: see Universities

Cybernetics: see Computer, inclusive

D.A.R.T. (Demand-Actuated Road Transit): see Demand-Responsive Systems

Damping: see Noise and Noise Control; see Wheels; see Tracks and Trackage

Dashaveyor Transit System: see People Movers, Dashaveyor

Data Analysis: see Quantitative Analysis

Data Collection: see Surveys

Data Processing: see Computer, inclusive

Day Rates: see Fare, cost determination

Delay Time: see Headways; see Time Costs

Delivery Service: see Freight Movement

Demand-Actuated Systems: see Demand-Responsive Systems; see Personal Rapid Transit

DEMAND-RESPONSIVE SYSTEMS: see also Personal Rapid Transit

pp. 61, 75, 85, 91, 92, 103, 104, 108, 215, 281, 286, 312, 322, 335, 361, 362, 386, 410

DEMAND-RESPONSIVE SYSTEMS, DIAL-A-RIDE

pp. 76-84, 86-88, 163, 379, 380, 392

DEMOGRAPHY: see also Center City; see also Urban Development, inclusive
pp. 19, 21, 24, 26, 60, 63, 92, 95, 109, 112, 113, 117, 120, 123, 139, 154, 156,
157, 162, 167, 169, 181, 182, 216, 218, 220, 228, 237, 238, 246, 253, 318, 366,
368, 372, 377, 378, 380, 381, 390, 397, 399, 402, 419, 430, 433, 451, 452, 454,
465

Density: see Demography

DEPRECIATION: see also Urban Development, renewal
p. 219

Destination: see Trip Generation

Deterioration: see Depreciation

Detours: see Traffic, control; see Traffic, congestion

Dial-A-Ride: see Demand-Responsive Systems, Dial-A-Ride

Diesel Engines: see Propulsion Systems, diesel

Diesel Fuel: see Fuel, types

Digital Computer: see Computer, programming

Direct Current Motors: see Propulsion Systems, electric

Disaster Preparedness: see Emergency Vehicles and Services

Discriminate Analysis: see Quantitative Analysis

Dislocations: see Relocation

Distribution, Land: see Land Use

Distribution, Power: see Power Distribution

DISTRIBUTION SYSTEMS: see also People Movers, inclusive
pp. 129, 193, 195-197, 243, 282, 293, 298, 306, 307, 312, 335, 353, 371, 386

Divided Highways: see Highway, types; see Lane Separation

DRAG: see also Aerodynamics
pp. 39-42, 57, 394

Drilling: see Boring and Boring Machines; see Tunnels and Tunneling

Driver: see Bus, driver; see Private Transportation, driver

DUAL MODE SYSTEMS: see also Bi-Modal Systems
pp. 102, 130-134, 143, 144, 289, 295, 358-360, 376, 382, 392, 410, 456

Ecology: see Environment and Environmental Control

Economic Analysis: see Quantitative Analysis; see Financing Mass Transportation, inclusive

Education: see Universities; see Management, training techniques

ELDERLY

pp. 27, 188, 210, 332, 383, 393, 430

Electric Automobiles: see Private Transportation, automobile

Electric Batteries: see Batteries and Cells

Electric Locomotives: see Rail, rolling stock; see Propulsion Systems, electric

Electric Propulsion: see Propulsion Systems, electric

Electrolytic Cells: see Batteries and Cells

ELECTRONIC VEHICLE GUIDANCE: see also Guides and Guidance; see also Headways

pp. 129, 286, 379

Elevated Highways: see Highways, types

Elevation: see Topography

EMERGENCY VEHICLES AND SERVICES

p. 329

Empirical Equations and Methods: see Quantitative Analysis

EMPLOYMENT

pp. 20, 27, 28, 30, 63, 65, 82, 92, 93, 106, 109, 121, 147, 151, 179, 181, 188, 216, 235, 246, 273, 274, 369, 384, 399, 401, 411, 433, 435, 437, 442, 451

Employment, distance: see Trip Generation

Energy Storage: see Batteries and Cells; see Flywheels

Engines: see Propulsion Systems, inclusive

ENVIRONMENT AND ENVIRONMENTAL CONTROL: see also Air Pollution; see also Noise and Noise Control; see also Land Use; see also Urban Development, inclusive; see also Crime and Crime Prevention

pp. 34, 35, 46, 47, 50-52, 54-56, 104, 148, 217, 319, 324, 337, 340, 351, 381, 387, 410, 413, 449

Environmental Improvement Program (E.I.P.): see Air Pollution

Equipment, cost and maintenance: see specific equipment; see Maintenance, inclusive

Escalators: see Conveyors

Ethnic Groups: see Race

Exclusive Bus Lanes: see Bus, priorities; see Lane, reserved

Exhaust Gases and Control: see Air Pollution

Express Bus: see Bus, express

Express Lanes: see Bus, priorities; see Lane, reserved

Expressways: see Highway, types

External Combustion Engine: see Propulsion Systems, external combustion

Factor Analysis: see Quantitative Analysis

FARES

pp. 26, 94, 123, 168, 241, 409

FARES, COLLECTION

pp. 2, 12, 14, 61, 99, 136, 146, 228, 309, 330, 332, 363, 428

FARES, COST DETERMINATION

pp. 17, 25, 29, 30, 61, 65, 76, 82, 86, 90, 92, 99, 103, 107-112, 122, 142, 147,
152, 161, 175, 182, 183, 185, 198, 199, 203-205, 213, 214, 222, 225, 229, 245,
250, 253, 302, 332, 416, 439, 442

FARES, PASSES: see also specific ridership groups [eg. Elderly]

pp. 140, 393

FARES, REDUCTION

pp. 14, 23, 74, 111, 112, 147, 213, 238, 332, 393

FASTENERS AND FASTENINGS

pp. 8, 11

Federal Government: see Government, Federal

Feeders and Feeder Service: see Bus, feeder; see Rail, feeder; see Bi-Modal Systems

Fiber Glass: see Construction, materials; see Rail, materials

Financing Highways: see Highway, financing

FINANCING MASS TRANSPORTATION

pp. 17, 85, 106, 109, 111, 120-122, 156, 165, 170, 172, 173, 175, 186, 190, 199, 209, 214, 223, 225, 388, 392, 400, 423, 444, 463

FINANCING MASS TRANSPORTATION, REQUIREMENTS

pp. 13, 25, 76, 94, 99, 105, 114, 125, 134, 149, 153, 169, 178, 182-184, 207, 211, 212, 218, 220, 227, 228, 230, 235, 236, 239, 244, 247, 253, 333, 372, 416

FINANCING MASS TRANSPORTATION, SOURCES

pp. 30, 31, 33, 102, 117, 174, 176, 185, 203, 204, 226, 229, 252, 294, 295, 302-304, 310, 439, 450, 459

FIRE PREVENTION AND CONTROL

p. 330

Fixed-Time Traffic Signals: see Signs and Signals

FLANGES

pp. 281, 354

Flexible Pavements: see Highway, surfaces

Flow of Traffic: see Traffic, flow

FLUIDS AND FLUID MECHANICS

pp. 40, 394

FLYWHEELS

pp. 311, 352

Four-Lane Highways: see Highways, types; see Lane Separation

Free Transit Systems: see Fares, cost determination

Freeways: see Highways, types

FREIGHT MOVEMENT

pp. 166, 213, 225, 234, 277, 278, 340, 417, 433

Frequencies, Radio: see Communications

Frequencies, Scheduling: see Headways; see Schedules and Scheduling

Fringe Area: see Demography; see Urban Development, inclusive

Fuel Cells: see Batteries and Cells

Fuel Exhaust: see Air Pollution

FUEL INJECTION

p. 148

FUEL, TYPES

pp. 311, 355, 374

Fumes: see Air Pollution

GAMES AND GAME THEORY: see also Computer, inclusive

pp. 124, 422

Garages: see Parking, facilities; see Maintenance, facilities

Gas Turbines: see Propulsion Systems, turbines

Gasoline Engines: see Propulsion Systems, internal combustion

General Electric Aerial Transport System: see People Movers, General Electric Aerial Transport

Glossaries: see Bibliographies

GOVERNMENT, COUNTY

pp. 21, 155, 176, 226, 275, 451, 453

GOVERNMENT, FEDERAL

pp. 33, 70, 83, 85, 102, 149, 153, 176, 190, 207, 226, 227, 252, 254, 259, 273, 275, 294, 295, 301-306, 310, 339, 341, 344, 350, 388, 400, 413, 421, 423, 425, 427, 459, 463

GOVERNMENT, INTERGOVERNMENTAL RELATIONS

pp. 33, 172, 197, 252, 275, 294, 303, 310, 388, 400, 413, 414, 421, 423, 439, 459

GOVERNMENT, STATE

pp. 83, 149, 152, 197, 246, 252, 275, 302-304, 309, 388, 412-414, 439, 459

GOVERNMENT, TAXATION

pp. 149, 153, 169, 176, 203, 229, 235, 252, 302, 439

GOVERNMENT, URBAN

pp. 31-33, 84, 117, 149, 150, 153, 158, 169, 173-176, 182, 184, 186, 197, 198, 209, 211, 226, 228-230, 232, 244, 252, 254, 274, 275, 294, 295, 301-306, 310, 329, 380, 388, 408, 412-414, 423, 425, 427, 439, 448, 451-453

Grades and Gradients: see Topography

Graduate Study: see Universities

Graphics: see Signs and Signals

Gravel: see Highway, surfaces; see Construction, materials

Gravity-Vacuum Tube Transit: see Tubes and Tube Vehicles

Grids and Grid Systems: see Routes and Routing

Ground Effect Vehicle: see Air Cushion Vehicle

GUIDES AND GUIDANCE: see also Electronic Vehicle Guidance .
pp. 131, 312, 320-322, 362

GUIDEWAYS

pp. 31, 64, 129-131, 160, 233, 251, 276-279, 281, 282, 286-289, 292, 293, 312, 321,
341, 346, 358-360, 376, 379, 382, 386, 392, 410

HANDICAPPED

pp. 196, 383

Hard-Core Unemployed: see Employment; see Inner City; see Poverty

HEADWAYS

pp. 17, 18, 59, 123, 128, 129, 168, 201, 210, 241, 293, 295, 307, 312, 320-322, 328,
405

HEATING: see also Thermodynamics

pp. 34, 46, 47, 49, 50, 55, 81, 324, 328

Helicopters: see Aircraft, V.T.O.L.

High Speed Ground Transport: see People Movers, inclusive; see Rail, inclusive

Highway Administration: see Government, inclusive

Highway Congestion: see Traffic, congestion

Highway, express lanes: see Bus, priorities; see Lane, reserved

HIGHWAY, FINANCING

pp. 400, 412

Highway, laws and legislation: see Government, inclusive

Highway, lighting: see Lights and Lighting

HIGHWAY, MAINTENANCE .

p. 438

HIGHWAY, PLANNING

pp. 165, 204, 234, 267, 268, 275, 347, 359, 390, 400, 408, 412-414, 425, 433, 445,
452-454

Highway Safety: see Safety

HIGHWAY, SURFACES

pp. 251, 438, 447

Highway, taxation: see Government, taxation

Highway, traffic control: see Traffic, control

HIGHWAY, TYPES

pp. 242, 296, 346, 347, 360, 389, 445, 447, 452, 466

HILL CLIMBING

pp. 311, 352

Horsepower: see Propulsion Systems, horsepower

Hospitals: see Medical Centers

Households: see Surveys; see Demography

HOUSING

pp. 275, 298, 347, 402, 424, 448, 451, 465

Hovercraft: see Air Cushion Vehicle

Hybrid Electric Powerplant (H.E.P.): see Propulsion Systems, hybrid

HYDRAULICS

pp. 6, 313, 328

Hydrocarbons: see Air Pollution

HYDROFOILS: see also Air Cushion Vehicle

p. 13

Illumination: see Lights and Lighting

Income: see Demography; see Ridership, profiles

Indexes and Indexing: see Bibliographies

INDUSTRIAL AND LABOR RELATIONS: see also Manpower and Personnel

pp. 62, 84, 93, 98, 102, 106, 176, 241, 259, 273, 385, 427, 437

Industrial Areas: see Land Use; see Urban Development, inclusive

INFORMATION AIDS

pp. 107, 113, 141, 196, 214, 215, 222, 231, 237, 241, 329, 350, 383, 441

Information Dissemination: see Public Relations; see Signs and Signals; see Advertising and Promotion; see Information Aids

Information Retrieval: see Computer, inclusive

Information Systems: see Management, operations and techniques

INNER CITY

pp. 27, 28, 65, 82, 93, 106, 108, 147, 190, 216, 273, 274, 377, 384, 399, 401, 414, 418, 442, 446

Input-Output Devices: see Computer, inclusive; see Instrumentation

INSTRUMENTATION

pp. 1-4, 9, 10, 12, 41, 128, 320, 326, 361, 363

INTERCITY TRANSPORTATION: see also specific modes

pp. 154, 392

INTERFACES

pp. 99, 180, 195, 221, 251, 354, 387, 446

Intergovernmental Relations: see Government, intergovernmental relations

Interior Vehicle Design: see Vehicle, design

INTERMODAL COMPETITION

pp. 22, 76, 83, 84, 90, 98, 117, 135, 138, 204, 221, 246, 264, 303, 342, 356, 397, 410, 427, 431, 444, 459

Internal Combustion Engine: see Propulsion Systems, internal combustion

INTERSECTIONS AND CROSSINGS

pp. 314, 315, 362, 407

Intermittant-Entry Systems: see Access, planning and control

Interurban Transportation: see Intercity Transportation

Interviews and Interviewing: see Surveys

Jitney Bus: see Bus, jitney

Jobs: see Employment

JOINT DEVELOPMENT

pp. 304, 305, 376, 431, 432

Joint Fares: see Fares, cost determination; see Bus, transfers

JOINTS AND JOINING

p. 125

Junctions: see Intersections and Crossings

Jurisdiction: see Government, inclusive

Kerosene: see Fuel, types

Key Punches: see Computer, programming

KISS-AND-RIDE

p. 60

KINETIC ENERGY

pp. 101, 352

Labor Unions: see Industrial and Labor Relations

LAND, ACQUISITION

pp. 219, 326, 345, 402, 448

LAND USE: see also Urban Development, inclusive

pp. 64, 84, 117, 120, 125, 139, 156, 166, 179, 194, 219, 243, 245, 246, 251, 259,
265, 275, 299, 303, 304, 306, 336, 337, 345, 347, 371, 378, 380, 381, 390, 391,
397, 402, 423, 424, 448, 451, 452

LANE, RESERVED

pp. 274, 325, 461

LANE SEPARATION

p. 447

Lasars: see Boring and Boring Machines

Lateral Forces: see Vibrations

Lateral Routes: see Routes and Routing

Law Enforcement: see Crime and Crime Prevention

Legislation: see Government, inclusive

Leasing: see Public Ownership

Libraries: see Bibliographies; see Universities

LIGHTS AND LIGHTING

p. 395

LINE SUPERVISION

pp. 1, 66, 68, 69, 71

Linear Induction Motors: see Propulsion Systems, linear induction

Local Government: see Government, urban

Location Systems: see Vehicle, monitoring

Logic Circuits: see Computer, inclusive

LOGISTICS

p. 69

MAINTENANCE

pp. 69, 124, 182, 213, 334

MAINTENANCE, COSTS

pp. 125, 219, 328, 438

MAINTENANCE, EQUIPMENT

pp. 87, 438

MAINTENANCE, FACILITIES

pp. 54, 116, 190, 199, 201, 202, 207, 214, 219, 241, 254, 362

Maintenance, personnel: see Manpower and Personnel

MANAGEMENT

pp. 150, 156, 164, 189, 218, 230, 341, 362, 363

MANAGEMENT, OPERATIONS AND TECHNIQUES

pp. 17, 26, 28, 66, 69, 71, 110, 117, 124, 153, 158, 174, 175, 184, 198, 199, 205, 208, 209, 223, 226, 228, 229, 241, 322, 331, 332, 343, 344, 387, 388, 436, 443, 453, 463

MANAGEMENT, PLANNING AND ANALYSIS

pp. 25, 124, 152, 211, 223, 224, 226, 227, 229, 244, 259, 301, 303, 304, 343, 344, 385, 391, 443, 453, 458

MANAGEMENT, TRAINING TECHNIQUES

pp. 124, 228, 259, 301, 330, 343, 344

MANPOWER AND PERSONNEL

pp. 62, 82, 106, 124, 127, 343, 344

MAPS AND MAPPING: see also Topography; see also Information Aids

pp. 141, 192, 268, 403

MARKET RESEARCH: see also Demography

pp. 76, 77, 90, 113, 118, 139, 301, 383, 404, 416

Marketing: see Market Research; see Advertising and Promotion

Matching Funds: see Financing Mass Transportation, sources; see Highway, financing

MATERIALS HANDLING

pp. 278, 313, 323

Mathematical Analysis: see Quantitative Analysis

MEASURING AND MEASUREMENTS: see also Instrumentation
pp. 10, 391, 394, 403

Mechanical Fasteners: see Fasteners and Fastenings

Media: see Advertising and Promotion

Medians: see Lane Separation

MEDICAL CENTERS:

pp. 18, 24, 108, 121, 329

Merging Traffic: see Traffic, flow

METERS AND METERING

pp. 266, 361, 466

Metropolitan Areas: see Urban Development, inclusive

Metropolitan Government: see Government, urban

Mileage: see Speed and Speed Control

Minibus: see Bus, minibus

Minicar: see Private Transportation, automobile; see Dual Mode Systems

Minirail: see People Movers, inclusive; see Personal Rapid Transit

Mixed-Mode Systems: see Bi-Modal Systems; see Dual Mode Systems

Modal Selection: see Modal Split

MODAL SPLIT

pp. 23, 24, 61, 95, 98, 111, 126, 155, 167, 169, 178, 179, 184, 187, 191, 204, 218,
225, 232, 234, 240, 251, 257, 258, 260-262, 264, 267, 270, 271, 357, 364-366,
371, 381, 387, 398, 399, 403, 404, 417, 422, 431, 433, 440, 442, 455, 458, 465

Model Cities: see Urban Development, renewal

Monitoring: see Vehicle, monitoring; see Sensors

Monorail: see People Movers, monorail

Motors: see Propulsion Systems, inclusive

Moving Sidewalks: see Conveyors; see Sidewalks; see Pedestrians

Moving-Way Systems: see Conveyors

MUFFLERS

pp. 49, 148, 355

Multivariate Analysis: see Quantitative Analysis

Municipal Development: see Urban Development, inclusive

Municipal Government: see Government, urban

Municipal Ownership: see Public Ownership

NEW TOWNS

pp. 64, 240, 378, 380

Node-Oriented Transportation: see specific systems; see Distribution Systems

NOISE AND NOISE CONTROL

pp. 8, 11-13, 34, 46, 47, 56, 125, 148, 277, 280, 330, 352, 354, 356, 375, 390, 424, 449

Nonuser Benefits: see Social Benefits and Costs

Nuclear Energy: see Fuel, types

Occupations: see Employment

OFF-PEAK TRAFFIC

pp. 103, 383, 411

Off-Street Parking: see Parking facilities

Office Buildings: see Center City; see Trip Generation; see Joint Development

Open Cuts: see Tunnels and Tunneling

Open Space: see Land Use

Operating Costs: see Financing Mass Transportation, requirements; see Bus, cost;
see Rail, cost

Origin-Destination Studies: see Trip Generation; see Surveys

Outlying Areas: see Demography; see Urban Development, inclusive; see Suburbs

Overhead Costs: see Financing Mass Transportation, requirements; see Management, operations and techniques

OVERPASSES

p. 251

Owl Service: see Schedules and Scheduling

P.R.T. (Personal Rapid Transit): see Personal Rapid Transit

Parallel Routes: see Routes and Routing

Park-and-Ride: see Parking, park-and-ride

PARKING, CAPACITY AND DEMAND

pp. 135, 171, 179, 210, 296, 358, 360, 405, 417, 426, 429

PARKING, COST

pp. 116, 426, 428, 429

PARKING, FACILITIES

pp. 63, 74, 135, 137, 166, 178-180, 221, 234, 297, 298, 417, 426, 428, 429

PARKING, PARK-AND-RIDE

pp. 59, 60, 112, 126, 135, 147, 428

PARKING, PLANNING

pp. 114, 166, 178, 180, 213, 234, 295, 387, 417, 426, 429

PARKING, REGULATIONS

pp. 308, 426

Passengers: see Ridership, inclusive; see specific characteristics [eg. Age, Sex, Race]

PASSENGER COUNTERS

p. 128

Pavements: see Highway, surfaces

Peak-Hour Traffic: see Traffic, peak-hour

Peak-Loads: see Bus, commuter; see Rail, commuter; see Traffic, peak-hour

PEDESTRIANS

pp. 180, 193, 194, 196, 234, 263, 299, 300, 353, 386, 407

PEOPLE MOVERS: specific systems by brand name; see also subsystems under separate headings; see also Rail, inclusive; see also Personal Rapid Transit; see also Demand-Responsive Systems

pp. 122, 170, 173, 233, 263, 289, 293, 299, 307, 312, 382, 387

PEOPLE MOVERS, AERIAL TRANSIT SYSTEM

pp. 276, 288

PEOPLE MOVERS, ALDEN STARRCAR

pp. 129, 215, 277, 292

PEOPLE MOVERS, CARVEYOR

p. 353

PEOPLE MOVERS, DASHAVEYOR

pp. 129, 278, 292

PEOPLE MOVERS, GENERAL ELECTRIC AERIAL TRANSPORT

pp. 279, 288

People Movers, Gravity-Vacuum Tube Transit: see Tubes and Tube Vehicles

PEOPLE MOVERS, MONORAIL

pp. 125, 172, 217, 280

PEOPLE MOVERS, SCHERER MONOBEAM

pp. 280, 288

PEOPLE MOVERS, TRANSIT EXPRESSWAY

pp. 287, 396

PEOPLE MOVERS, TRANSIVATOR

pp. 281, 292, 353

PEOPLE MOVERS, VARO MONOCAB

pp. 129, 286, 292

PERSONAL RAPID TRANSIT

pp. 122, 233, 277, 278, 282, 289, 293, 312, 321, 322, 358-360, 376

Personal Transport Vehicles: see Private Transportation, inclusive

Personnel: see Manpower and Personnel

Piggyback: see Freight Movement

Plastics: see Construction, materials; see Rail, materials

PNEUMATICS

pp. 6, 283-285, 292

Point-to-Point Transit: see Trip Generation; see Demand-Responsive Systems; see Personal Rapid Transit

Police: see Crime and Crime Prevention

Politics: see Government, inclusive

Pollution: see Air Pollution; see Noise and Noise Control; see Environment and Environmental control

Population: see Demography

POVERTY: see also Inner City

pp. 18, 24, 27, 28, 30, 65, 82, 83, 93, 151, 181, 231, 273, 369, 383, 418, 435, 442

Power Collection: see Power Distribution; see Instrumentation

Power Conversion: see Propulsion Systems, inclusive

POWER DISTRIBUTION

pp. 4, 5, 7, 12, 101, 131, 143, 160, 192, 282, 330, 375

Power Plants: see Power Distribution; see Propulsion Systems, inclusive

Precast Concrete: see Highway, surfaces; see Construction, materials

PRESSURE AND PRESSURE MEASUREMENT

pp. 37, 51, 58, 328

Prestressed Concrete: see Highway, surfaces; see Construction, materials

Primary Highways: see Highway, types

PRIVATE TRANSPORTATION

pp. 74, 121, 122, 230, 263, 431

PRIVATE TRANSPORTATION, AUTOMOBILE

pp. 14, 22, 30, 59, 76, 82, 96, 98, 114-116, 120, 138, 187, 200, 204, 210, 216, 240, 267, 295, 296, 298, 308, 342, 368, 377-380, 399, 406, 410, 414, 417, 426, 429, 444

PRIVATE TRANSPORTATION, BUS

pp. 212, 221, 230

PRIVATE TRANSPORTATION, CAR POOLS

pp. 188, 308, 325

PRIVATE TRANSPORTATION, DRIVER

pp. 20, 308, 406, 444, 447, 462

PRIVATE TRANSPORTATION, TAXICABS

pp. 76, 83, 84, 98, 103, 356, 433

Probability Theory: see Quantitative Analysis

Programming: see Computer, programming

Promotional Techniques: see Advertising and Promotion

PROPULSION SYSTEMS

pp. 81, 334, 341, 373, 375, 382

PROPULSION SYSTEMS, DIESEL

pp. 144, 148, 355

PROPULSION SYSTEMS, ELECTRIC

pp. 4, 7, 12, 143, 144, 278, 279, 287, 292, 311, 355, 358, 359

PROPULSION SYSTEMS, EXTERNAL COMBUSTION

p. 355

PROPULSION SYSTEMS, HORSEPOWER

p. 352

PROPULSION SYSTEMS, HYBRID

pp. 131, 311, 351, 352, 355

PROPULSION SYSTEMS, INTERNAL COMBUSTION

pp. 352, 355

PROPULSION SYSTEMS, LINEAR INDUCTION

pp. 160, 279, 282, 292, 293

PROPULSION SYSTEMS, TURBINES

pp. 143, 144, 242, 355

Public Address Systems: see Communications

Public Administration: see Government, inclusive

Public Opinions: see Ridership, profiles; see Surveys; see Community Response

PUBLIC OWNERSHIP

pp. 117, 119, 150, 152, 153, 155, 169, 172, 174-176, 183, 185, 186, 198, 207, 209, 211-213, 223, 224, 227-229, 231, 232, 239, 242, 244, 453, 463

Public Parking: see Parking, inclusive

PUBLIC RELATIONS

pp. 30, 32, 63, 65, 82, 113, 125, 141, 175, 237, 238, 301, 302, 342, 350, 408, 412, 413, 462

Public Support: see Community Response; see Financing Mass Transportation, sources

QUALITATIVE ANALYSIS

pp. 69, 89, 103, 114, 150, 151, 164, 189, 246, 287, 290, 335, 337, 362, 364-370, 375, 383, 404, 408, 409, 420, 432, 435, 441, 443, 449, 464

QUALITY CONTROL

pp. 5, 11, 22, 68, 77, 143, 164, 195, 248, 255, 317, 334, 336, 337, 340-342, 351, 381, 382, 420, 449, 464

QUANTITATIVE ANALYSIS

pp. 17, 23, 36-40, 42, 45, 57, 58, 67, 68, 76, 77, 100, 105, 114, 127, 164, 181, 187, 200, 219, 263, 265, 271, 273, 274, 287, 291, 311, 332, 336, 337, 341, 349, 362-371, 381, 394, 396, 398, 399, 402-404, 406, 409, 419, 420, 424, 430-433, 435, 437, 440, 445, 447, 449, 451, 454, 460, 462, 465, 466

Questionnaires: see Surveys

RACE

pp. 19, 22, 32, 93, 216, 273, 399, 401, 414, 418, 442

Radio: see Communications

RAIL: see also People Movers, specific types

pp. 263, 405

RAIL, AUTOMATIC CONTROL

pp. 1, 4, 5, 9, 12, 217, 277, 321, 322, 326, 334, 387

Rail-Bus: see Dual Mode Systems

Rail, car: see Rail, rolling stock

RAIL, COMMUTER

pp. 60, 74, 98, 99, 109-111, 129, 135-138, 142, 144, 154, 178-181, 249, 270, 333, 410, 427

RAIL, COST

pp. 74, 111, 161, 173, 217, 218, 280, 289, 333

Rail, fasteners: see Fasteners and Fastenings

RAIL, FEEDER

p. 60

Rail, laboratory cars: see Testing Facilities

RAIL, MATERIALS

pp. 7, 8, 11, 334, 354, 382

RAIL, ROLLING STOCK

pp. 5, 34, 36, 39, 45, 49-51, 53-56, 100, 101, 143, 144, 190, 191, 217, 280, 282, 284, 290, 293, 328, 330, 334, 354, 395, 427

RAIL, STATIONS AND TERMINALS

pp. 34, 36, 44, 46, 47, 49-51, 53-56, 58, 100, 135, 136, 160, 166, 167, 178-180, 190, 192, 217, 221, 248, 255, 276, 277, 280, 282, 357, 387, 395, 448, 450

RAIL, SYSTEMS PLANNING AND DESIGN

pp. 1, 14, 31, 32, 35, 37, 38, 46, 47, 50-56, 60, 97, 100, 159, 160, 164, 167, 170, 173, 189-192, 217, 218, 233, 248, 249, 253, 276-280, 282, 288, 289, 293, 312, 321, 323, 330, 333, 339, 342, 371, 376, 413, 423, 427, 448, 452

Rail, tracks: see Tracks and Trackage

Rapid Rail: see Rail, inclusive

Real Estate: see Land Use; see Land, acquisition

Receivers: see Communications

Recorders: see Instrumentation; see Measuring and Measurements

RECREATIONAL FACILITIES

p. 419

Recruitment: see Manpower and Personnel

Rectifiers: see Instrumentation; see Propulsion Systems, electric

Referendum: see Government, inclusive; see Financing Mass Transportation, sources

Regenerative Braking: see Brakes and Braking, regenerative

Regional Planning: see Urban Development, planning

Regulations: see Government, inclusive; see Parking, regulations

Reinforced Concrete: see Highway, surfaces; see Construction, materials

RELOCATION

pp. 30, 219, 412

Remote Control: see specific devices; see Rail, automatic control

Remote Sensing: see Sensors; see Vehicle, monitoring

Replacement Costs: see Maintenance, costs; see Relocation

RESEARCH OPERATIONS

pp. 25, 52, 88, 134, 259, 331, 373-375, 379, 384-386, 420

Reserved Lanes: see Bus, priorities; see Lane, reserved

Residential Areas: see Housing; see Demography; see Suburbs

Resistors: see Batteries and Cells; see Propulsion Systems, electric

Revenue: see Financing Mass Transportation, inclusive; see Fares, cost determination

Revenue Sharing: see Government, Federal

Reverse Commute: see Bus, commuter

Reversible Traffic Lanes: see Traffic, flow; see Traffic, control

Ride Quality: see Vehicle, design; see Quality Control; see specific modes

RIDERSHIP: see also Surveys; see also specific aspects of Ridership [eg. Age, Modal Split, Trip Generation, Bus commuter, etc.]

pp. 14, 20, 23, 25, 26, 28, 29, 85, 92, 98, 100, 108, 112, 119, 140, 155, 167, 172, 174, 185, 186, 198, 235, 236, 238, 241, 247, 248, 263, 265, 273, 290, 291, 305, 337, 366, 372, 398, 409, 411, 416, 432, 437, 457

RIDERSHIP, ATTRACTION

pp. 17, 59, 63, 74, 89, 110, 111, 113, 118, 126, 133, 135, 137, 138, 141, 147, 162, 215, 264, 301, 342, 381, 435, 441, 444, 462, 464

RIDERSHIP, PROFILES

pp. 19, 21, 22, 24, 82, 121, 151, 152, 157, 169, 175, 177, 181, 182, 188, 200, 204, 222, 225, 231, 232, 262, 270-272, 332, 430, 433, 442, 465

RIDERSHIP, VOLUME

pp. 13, 18, 60, 95, 117, 161, 168, 171, 178, 179, 184, 187, 199, 209, 214, 218, 220, 223, 224, 227, 240, 253, 274, 318, 357, 371, 377, 393, 404, 405, 427

RIGHT-OF-WAY

pp. 125, 233, 243, 247, 248, 251, 328, 345, 378, 381, 387, 409, 448

ROADBEDS

pp. 54, 354

Roads: see Highways, inclusive

Roadside Development: see Highways, planning

Robberies and Assaults: see Crime and Crime Prevention

Rock Cutting: see Boring and Boring Machines

Rock Formations: see Structural Analysis; see Topography

ROUTES AND ROUTING: see also Schedules and Scheduling; see also Computer, applications; see also Trip Generation

pp. 14, 15, 17, 18, 21, 24, 25, 61, 62, 65, 75, 79, 80, 82, 88, 90, 91, 94, 95, 103, 106-109, 112, 119, 121, 123, 128, 145, 149, 152, 155, 156, 159, 160, 162, 163, 165, 167, 172, 174, 175, 177, 181-184, 188, 192, 198, 201, 202, 206, 210, 215, 216, 219, 220, 222, 225, 228, 232, 235, 237, 239, 241, 243, 247, 248, 253, 274, 286, 332, 363, 383, 416, 422, 423, 425, 435, 455, 457, 458

Rubber Tires: see Wheels

Run-Cutting: see Schedules and Scheduling; see Manpower and Personnel

Rush-Hour Traffic: see Traffic, peak-hour

SAFETY

pp. 11, 69, 81, 125, 166, 195, 197, 222, 276, 330, 334, 362, 447

SCHEDULES AND SCHEDULING: see also Routes and Routing; see also Computer, applications

pp. 13, 17, 18, 29, 62, 69, 94, 102, 109-112, 117, 121, 123, 127, 128, 137, 138,
158, 179, 188, 198, 210, 215, 220, 225, 239, 264, 283, 411, 442

Scherer Monobeam: see People Movers, Scherer Monobeam; see Suspensions

School Buses: see Bus, school bus

Scrip: see Fare, collection

SEATS AND SEATING

p. 22

Secondary Roads: see Highways, types

Security: see Crime and Crime Prevention

SENSORS: see also Vehicle, monitoring

pp. 5, 128, 314, 315, 317, 320, 329, 331, 361, 363, 374, 386, 391, 466

SEX

pp. 19, 22, 177, 200

Share-the-Rail: see Dual Mode Systems

Shelters: see specific modes; see Bus, stations and shelters

Shipping: see Freight Movement

Shirley Highway: see Bus, priorities; see Lane, reserved

Shoppers: see Fare, reduction; see Ridership, profiles; see Trip Generation

Shops and Garages: see Maintenance, facilities

Shuttle Buses: see Bus, feeder; see Bus, shuttle

Shuttle Trains: see Rail, feeder

SIDEWALKS

pp. 193-197, 299, 300, 306

Sidewalks, moving: see Conveyors

Signals: see Signs and Signals

SIGNS AND SIGNALS

pp. 1, 6, 102, 107, 141, 192, 196, 205, 314, 315

Simulations: see Computer, applications; see Games and Game Theory

Single-Lane Traffic: see Lane Separation; see Traffic, flow

SITE SELECTION

pp. 84, 103, 166, 219, 326, 433, 446, 448

SKIRTS

p. 13

SKOKIE SWIFT

pp. 60, 178, 179

Sky-Kar Transivator System: see People Movers, Transivator

Skybus: see People Movers, Transit Expressway

Skylounge: see Aircraft, V.T.O.L.; see Airport, access

Slums: see Urban Development, renewal; see Housing; see Poverty; see Inner City

Small Car Systems: see Private Transportation, automobiles

SMALL CITIES

pp. 96, 112, 162, 185, 231, 372

Smog Control: see Air Pollution

SOCIAL BENEFITS AND COSTS

pp. 20, 133, 141, 162, 163, 211, 226, 229, 273, 337, 349, 364, 365, 367-370, 380, 392, 396, 408, 410, 411, 420, 431, 432, 435, 439, 464

Social Planning: see Social Benefits and Costs

Socioeconomic Status: see Ridership, profiles; see Poverty

Software, computer: see Computer, programming

Solid State: see Instrumentation

Sound Absorption: see Noise and Noise Control; see Mufflers

Spacing: see Headways

Spectrum Utilization: see Communications

SPEED AND SPEED CONTROL

pp. 1, 4, 9, 39, 41, 45, 160, 193, 195, 267, 276, 279, 281, 283-286, 290, 311, 321, 327, 352, 379, 394, 407, 409, 447

Springs: see Suspensions

Staggered Hours: see Traffic, flow; see Traffic, control

Stainless Steel: see Construction, materials; see Rail, materials

State Government: see Government, state

Stations: see specific modes

Statistics: see Surveys; see Quantitative Analysis; see specific types [eg. Ridership, volume; Modal Split; Budgets and Budget Planning, etc.]

Steel: see Construction, materials; see Rail, materials

Steel Wheel: see Wheels

Stopping Distances: see Speed and Speed Control; see Brakes and Braking, inclusive

Storage Batteries: see Batteries and Cells

Stratification, geological: see Topography

Stratification, social: see Demography; see Ridership, profiles

Stress: see Structural Analysis

Strikes: see Industrial and Labor Relations

STRUCTURAL ANALYSIS

pp. 218, 288, 420

Students: see Youth; see Universities; see Bus, school bus; see Ridership, profiles

Subsidies: see Government, inclusive; see Financing Mass Transportation, inclusive

Subsurface Structures: see Underground, structures

SUBURBS

pp. 28, 115, 118, 139, 147, 178, 274, 360

SUBURBS, BUSINESS DISTRICTS

pp. 93, 99, 122, 135, 180, 389

Suburbs-City Bus: see Bus, commuter

Suburbs-City Feeder Service: see Bus, feeder; see Rail, feeder

Suburbs-City Rail: see Rail, commuter

Suburbs-City Rapid Transit: see Rail, commuter; see Bus, rapid transit

Subways: see Rail, inclusive; see Underground, structures

Subways, air conditioning: see Air Conditioning

Subways, car construction and design: see Rail, rolling stock

Subways, environment: see Environment and Environmental Control; see specific aspects [eg. Heating, Thermodynamics, Pressure and Pressure Measurement, etc.]

Subways, planning: see Rail, systems planning and design

Subways, stations: see Rail, stations and terminals

Summer Youth Programs: see Youth

Surface Effect Vehicle: see Air Cushion Vehicle

Surveillance: see Crime and Crime Prevention; see Vehicle, monitoring

SUSPENSIONS

pp. 5, 7, 10, 45, 279, 282, 284, 288, 334, 351, 374

SURVEYS

pp. 13, 18-21, 24, 26, 30, 60, 61, 63, 74, 89-91, 98, 111, 112, 120, 121, 123, 125, 126, 136, 139, 140, 150, 151, 153, 155, 157, 161, 163, 173-175, 177, 182, 185, 188, 194, 200, 204, 209, 216, 222-225, 231, 235, 237, 238, 240, 247, 264, 269-272, 274, 300, 301, 305, 318, 330, 340, 366, 374, 381, 383, 393, 395, 401, 414, 405, 411, 412, 441, 444, 446, 454, 459, 460, 462, 464

SWITCHES AND SWITCHING

pp. 125, 276, 277, 282, 288, 293, 307, 353

Systems Analysis: see specific systems; see Quantitative Analysis; see Qualitative Analysis

T.A.C.V. (Tracked Air Cushion Vehicle): see Air Cushion Vehicle

Taxes and Taxation: see Government, taxation

Taxicabs: see Private Transportation, taxicabs

TAXONOMY

pp. 312, 410

Television: see Advertising and Promotion; see Communications

Terminals: see Rail, stations and terminals; see Bus, stations and shelters

TESTING FACILITIES

pp. 1, 3, 12, 41, 43, 44, 48, 58, 77, 144, 326, 330, 339

THERMODYNAMICS

pp. 38, 42, 43, 50, 51, 54

TIME COSTS: see also Speed and Speed Control

pp. 18, 23, 76, 98, 114, 133, 216, 264, 396, 409, 434, 438, 444, 446, 462

Time Sharing: see Computer, applications

TOPOGRAPHY

pp. 14, 160, 278, 300, 414

Track-Sharing: see Dual Mode Systems

Tracked Air Cushion Vehicle: see Air Cushion Vehicle

TRACKS AND TRACKAGE: see also Rail, materials

pp. 7-9, 11, 12, 36, 45, 46, 53, 54, 102, 190, 288, 330, 354

Traction Motors: see Propulsion Systems, electric

TRAFFIC, ANALYSIS

pp. 95, 102, 103, 234, 240, 314, 347, 391, 406, 407, 445-447

TRAFFIC, CONGESTION

pp. 20, 115, 135, 171, 210, 213, 242, 267, 297, 298, 325, 358, 396, 414

TRAFFIC, CONTROL

pp. 267, 268, 308, 314-317, 361, 362, 374, 386, 389, 438, 466

TRAFFIC, FLOW

pp. 95, 115, 213, 267, 296, 308, 314, 315, 318, 325, 360, 361, 372, 378, 386, 389, 445, 461, 466

Traffic, forecasting: see Traffic, analysis; see Modal Split

TRAFFIC, PEAK-HOUR

pp. 63, 95, 103, 126, 140, 194, 213, 215, 220, 242, 266, 267, 308, 318, 325, 410, 417, 461

Traffic, safety: see Safety

Traffic, signals: see Signs and Signals

Traffic, volume: see Traffic, flow

Training Programs: see Management, training techniques; see Manpower and Personnel

Trains: see Rail, inclusive

Transit Authority: see Government, inclusive; see Public Ownership; see Management

Transit Expressway: see People Movers, Transit Expressway

Transivator: see People Movers, Transivator

Travel Patterns and Demand: see Trip Generation; see Modal Split; see Ridership, inclusive

Tread: see Wheels; see Brakes and Braking, inclusive

Trenching: see Tunnels and Tunneling

Trip Distribution: see Trip Generation

TRIP GENERATION

pp. 14, 18, 19, 21, 23-25, 29, 60, 61, 63, 89, 91, 94-96, 98, 103, 107, 108, 113, 117, 118, 121, 123, 135, 137, 140, 155, 156, 167-169, 174, 177, 182, 184, 185, 187, 194, 198, 200, 204, 225, 232-235, 240, 246, 247, 253, 257, 258, 262, 265, 270, 272, 296, 300, 335, 366, 369, 377, 378, 389, 399, 401, 403, 410, 417-419, 422, 430, 433, 434, 437, 440, 442, 446, 455, 457, 458, 460, 465

Trip Length: see Ridership, profiles; see Time Costs; see Trip Generation

TRUCKS AND TRUCK LINES: see also Freight Movement; see also Rail, rolling stock

pp. 5, 12, 166, 234, 340

TUBES AND TUBE VEHICLES

pp. 35, 40-42, 48, 52, 283-285, 288, 293, 326-328, 394

TUNNELS AND TUNNELING

pp. 34, 36, 37, 46, 47, 49, 50, 53, 54, 56, 248, 283-285, 287, 297, 313, 319, 323, 324, 373, 374, 382

Turbines: see Propulsion Systems, turbines

Two-Lane Highways: see Highway, types; see Lane Separation

Two-Way Communications: see Communications

Underground, parking: see Parking, facilities

Underground, railroads: see Rail, inclusive

UNDERGROUND, STRUCTURES

pp. 34-36, 44, 49-53, 100, 255, 328

Unemployment: see Employment

UNIVERSITIES

pp. 21, 343, 415, 426

URBAN DEVELOPMENT, PLANNING

pp. 33, 64, 117, 155, 159, 162, 165-167, 170, 194, 196, 209, 217, 218, 233, 234, 253, 262, 275, 294, 295, 299, 303-306, 329, 336-338, 340, 341, 345, 347, 349, 365, 372, 377-381, 389, 390, 392, 397, 402, 407, 408, 412-414, 418, 421, 429, 431, 432, 443, 445, 448, 451, 452, 456, 459

URBAN DEVELOPMENT, RENEWAL

pp. 151, 194, 216, 234, 275, 304, 408, 465

User Benefits: see specific modes; see specific types

User Charges: see Fares, inclusive

V.T.O.L.: see Aircraft, V.T.O.L.

Vandalism: see Crime and Crime Prevention

VEHICLE, DESIGN: see also specific modes [eg. Bus, design; Rail, systems planning and design]

pp. 5, 8, 29, 35, 36, 45, 52-56, 104, 122, 130, 190, 248, 276-280, 291, 305, 309, 312, 334, 335, 341, 342, 348, 351, 357, 358, 364, 376, 394

Vehicle, guidance: see Guides and Guidance; see Electronic Vehicle Guidance

VEHICLE, MONITORING

pp. 6, 66-73, 80, 103, 266, 278, 314, 320, 329, 331, 362, 391, 466

Vehicular Communications: see Communications

Ventilation: see Air Conditioning; see Heating; see Environment and Environmental Control

Viaducts: see Overpasses

VIBRATIONS

pp. 8, 11, 13, 125, 291, 354

Visual Aids: see Signs and Signals; see Information Aids; see Advertising and Promotion

Waiting Time: see Time Costs; see Headways; see Schedules and Scheduling

Walkways: see Sidewalks

Warning Systems: see Signs and Signals; see Crime and Crime Prevention; see Vehicle, monitoring; see Safety; see Instrumentation

WEATHER EFFECTS

pp. 13, 34, 56, 356

Welfare: see Poverty; see Social Benefits and Costs

Westinghouse Transit Expressway: see Transit Expressway

WHEELS

pp. 5, 8-10, 53, 56, 102, 279, 290, 311, 354

Work Stoppages: see Industrial and Labor Relations

Work Trips: see Trip Generation; see Employment; see Rail, commuter; see Bus, commuter

YOUTH

pp. 99, 198, 210, 383, 430

Zoning: see Land Use

M.A.C.S. PROJECT NUMBERS

In the spring of 1972, UMTA instituted the Management Accounting and Control System (MACS), an automated system for processing UMTA project data. Consequently, a new numbering code for all projects has been developed. Numbers in this new series are not directly translatable into the "old" project numbers which were used to arrange abstracts in this volume (see The Indexing System).

The following table will permit users who are familiar only with the "new" project numbers to retrieve abstracts in Section I. The left-hand column in each pair lists these "new" numbers in alphabetical order; the right-hand column lists the corresponding "old" numbers.

It should be noted that only those projects whose reports are abstracted in Section I are included in the list. In addition, some abstracts relate to projects which were completed while the Federal programs in urban mass transportation were still administered by the Department of Housing and Urban Development. These projects were not assigned MACS numbers, and are therefore excluded from the list.

It is expected that with the passage of time, the new series will gain widespread acceptance and usage. Future updates of this publication will utilize the new numbering code.

<u>NEW #:</u>	<u>OLD #:</u>	<u>NEW #:</u>	<u>OLD #:</u>
AL-09-0001	ALA-T9-1	FL-09-0001	FLA-T9-1
AZ-09-0002	ARIZ-T9-2	FL-09-0002	FLA-T9-2
AK-09-0001	ARK-T9-1	FL-09-0003	FLA-T9-3
CA-06-0021	CAL-MTD-2	FL-09-0004	FLA-T9-4
CA-06-0022	CAL-MTD-3	FL-11-0012	URT-12
CA-06-0024	CAL-MTD-5	FL-11-0052	URT-52
CA-06-0027	CAL-MTD-8	GA-06-0002	GA-MTD-1
CA-06-0028	CAL-MTD-10	GA-09-0001	GA-T9-1
CA-06-0029	CAL-MTD-11	GA-11-0019	URT-19
CA-06-0030	CAL-MTD-12	HI-09-0002	HAW-T9-2
CA-06-0049	TRD-41	IA-09-0001	IOWA-T9-1
CA-06-0051	TRD-85	IA-09-0002	IOWA-T9-2
CA-09-0007	CAL-T9-7	IA-11-0032	URT-32
CA-09-0008	CAL-T9-8	IL-06-0007	ILL-MTD-1
CA-09-0009	CAL-T9-9	IL-06-0019	TRD-97
CA-09-0010	CAL-T9-10	IL-09-0002	ILL-T9-2
CA-09-0011	CAL-T9-11	IL-09-0003	ILL-T9-3
CA-11-0004	URT-4	IL-11-0020	URT-20
CO-09-0004	COLO-T9-4	IL-11-0021	URT-21
CT-06-0005	CONN-MTD-1	IN-09-0001	IND-T9-1
DC-06-0006	DC-MTD-2	IT-06-0007	INT-MTD-1
DC-06-0008	DC-MTD-5	IT-06-0008	INT-MTD-2
DC-06-0009	DC-MTD-6	IT-06-0009	INT-MTD-5
DC-06-0010	DC-MTD-7	IT-06-0010	INT-MTD-7
DC-06-0027	TRD-34	IT-06-0011	INT-MTD-8
DC-06-0029	TRD-42	IT-06-0012	INT-MTD-9
DC-06-0030	TRD-44	IT-06-0013	INT-MTD-10
DC-06-0031	TRD-46	IT-06-0014	INT-MTD-11
DC-06-0035	TRD-51	IT-06-0015	INT-MTD-12
DC-06-0036	TRD-53	IT-06-0017	INT-MTD-14
DC-06-0037	TRD-54	IT-06-0018	INT-MTD-15
DC-06-0040	TRD-59	IT-06-0020	INT-MTD-17
DC-06-0043	TRD-63	IT-06-0022	INT-MTD-20
DC-06-0047	TRD-69	IT-09-0002	INT-T9-2
DC-06-0049	TRD-72	IT-09-0004	INT-T9-4
DC-06-0051	TRD-76	IT-09-0005	INT-T9-5
DC-06-0052	TRD-77	IT-09-0006	INT-T9-6
DC-06-0053	TRD-78	IT-09-0015	INT-T9-15
DC-06-0054	TRD-81	KS-06-0001	KAN-MTD-1
DC-06-0058	TRD-86	KY-09-0002	KY-T9-2
DC-06-0064	TRD-101	LA-09-0002	LA-T9-2
DC-11-0003	DC-URT-3		
DC-11-0011	URT-11		
DC-11-0037	URT-37		

<u>NEW #:</u>	<u>OLD #:</u>	<u>NEW #:</u>	<u>OLD #:</u>
MA-06-0007	MASS-MTD-1	NY-06-0029	TRD-6
MA-06-0009	MASS-MTD-6	NY-09-0001	NY-T9-1
MA-06-0016	TRD-52	NY-09-0002	NY-T9-2
MA-09-0002	MASS-T9-2	NY-09-0003	NY-T9-3
MA-09-0004	MASS-T9-4	NY-09-0004	NY-T9-4
MA-09-0005	MASS-T9-5	NY-09-0005	NY-T9-5
MA-09-0006	MASS-T9-6	NY-11-0007	NY-URT-7
MA-11-0010	URT-9	NY-11-0029	URT-29
MD-06-0004	MD-MTD-1	OH-06-0011	OHIO-MTD-3
MD-06-0005	MD-MTD-2	OH-06-0015	TRD-36
MD-06-0006	MD-MTD-3	OH-09-0002	OHIO-T9-2
MD-06-0007	MD-MTD-4	OH-09-0003	OHIO-T9-3
MD-06-0009	TRD-43	OH-09-0005	OHIO-T9-5
MD-06-0011	TRD-73	OH-09-0006	OHIO-T9-6
MD-09-0001	MD-T9-1	OK-11-0015	URT-15
MI-06-0006	MICH-MTD-1	OR-09-0001	ORE-T9-1
MI-06-0007	MICH-MTD-2	OR-09-0002	ORE-T9-2
MI-09-0001	MICH-T9-1		
MN-09-0001	MINN-T9-1	PA-06-0008	PA-MTD-1
MN-11-0014	URT-14	PA-06-0010	PA-MTD-4
MN-11-0036	URT-36	PA-06-0011	PA-MTD-5
		PA-06-0012	PA-MTD-6
MS-09-0001	MISS-T9-1	PA-06-0013	PA-MTD-7
MS-09-0002	MISS-T9-2	PA-06-0014	PA-MTD-8
		PA-06-0023	TRD-111
MT-09-0001	MONT-T9-1	PA-09-0003	PA-T9-3
		PA-11-0005	URT-5
NC-09-0002	NC-T9-2	PA-11-0007	PA-URT-7
NC-09-0003	NC-T9-3	PA-11-0008	URT-8
NE-09-0003	NEBR-T9-3	RI-06-0003	RI-MTD-1
NJ-09-0003	NJ-T9-3	SC-09-0001	SC-T9-1
NY-06-0009	NY-MTD-5	TN-06-0001	TENN-MTD-1
NY-06-0011	NY-MTD-8	TN-06-0002	TENN-MTD-2
NY-06-0012	NY-MTD-9	TN-09-0002	TENN-T9-2
NY-06-0013	NY-MTD-10		
NY-06-0014	NY-MTD-11	TX-06-0006	TEX-MTD-4
NY-06-0015	NY-MTD-12	TX-06-0011	TRD-14
NY-06-0016	NY-MTD-13	TX-09-0001	TEX-T9-1
NY-06-0019	NY-MTD-16	TX-09-0003	TEX-T9-3
NY-06-0021	NY-MTD-18	TX-09-0004	TEX-T9-4
		TX-09-0009	TEX-T9-9

<u>NEW #:</u>	<u>OLD #:</u>
UT-09-0002	UTAH-T9-2
VA-06-0001	VA-MTD-1
VA-06-0002	VA-MTD-2
VA-06-0009	TRD-45
VA-06-0012	TRD-90
VA-09-0002	VA-T9-2
WA-06-0003	WASH-MTD-1
WA-06-0004	WASH-MTD-2
WA-09-0002	WASH-T9-2
WA-11-0016	URT-16
WA-11-0049	URT-49
WI-06-0001	WISC-MTD-2
WI-09-0001	WISC-T9-1
WI-09-0002	WISC-T9-2
WV-06-0001	WVA-MTD-1
WV-06-0002	WVA-MTD-2
WV-06-0003	WVA-MTD-3



DOT LIBRARY



00399520

