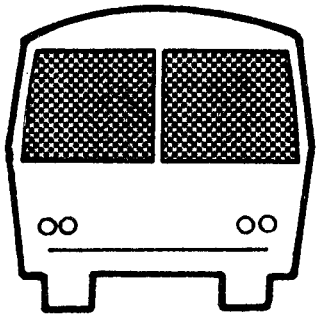
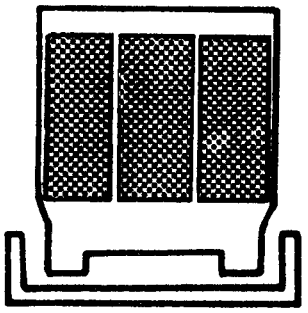
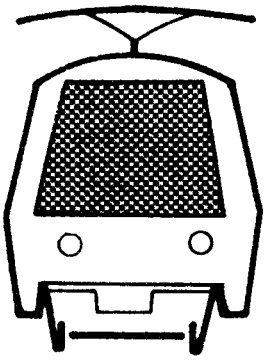
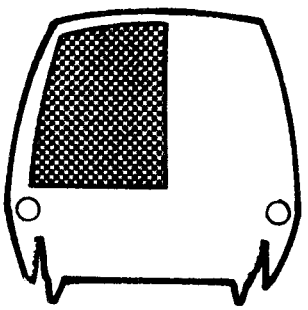
TRANSIT TECHNOLOGY SELECTION STUDY

TECHNICAL MEMORANDUM NO.1









TRANSITWAY TECHNOLOGY: AN ANNOTATED BIBLIOGRAPHY

North Central Texas Council of Governments

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TRANSITWAY TECHNOLOGY:
AN ANNOTATED BIBLIOGRAPHY

PREPARED FOR
NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS
AS A PART OF THE
TRANSITWAY EVOLUTION ALTERNATIVE STUDY

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Introduction

Current long-range transportation plans for the Dallas-Fort Worth Metropolitan Area call for the development of several transitways by 1990. These transitways will initially operate with buses and carpools; however, future conditions may make it desirable to change from buses to some other form of mass transit along these same rights-of-way. Hence, the feasibility of designing transit facilities that can be easily adapted to various forms of mass transportation is a legitimate concern.

"Transit Technology Selection Analysis for the Dallas-Fort Worth Intensive Study Area" is a study designed to evaluate the feasibility of designing transitways that can evolve from one form of mass transportation to others. A search of the published literature was conducted as one of the initial steps of the study. This annotated bibliography is the result of that literature review. Hopefully, it will be useful to other studies around the nation as well as to this specific study.

TRANSIT STUDIES FOR DALLAS-FORT WORTH

Barton-Aschman Associates, Inc. DALLAS SUBREGIONAL PUBLIC TRANSPORTATION STUDY. For North Central Texas Council of Governments, City of Dallas, and City of Fort Worth. November 1975, 300 pp.

The recommendations described in this report do not represent a rigid plan for the construction of transit facilities. The incremental development of a public transportation system is emphasized. The report outlines a basic strategy to be followed over a period of time. The approach attempts to create flexibility for future decisions, but still allows the area to start on a long-term transit improvement program. In addition, the report has a goals orientation; it emphasizes land-use/transportation relationships, and it continually deals in terms of a system. The report includes new information on cordon counts around the CBD, on-board bus passenger interviews, sidewalk interviews and pedestrian counts at selected locations in the CBD, and field surveys of the various transportation corridors being considered for the plan.

Marsden AS. et al. GREATER FORT WORTH TRANSIT PROGRAM, VOLUME 1. By Alan M. Voorhees and Assoc., Inc., Economic Research Assoc., and Skidmore Owings and Merrill as part of Dallas-Fort Worth Regional Public Transportation Study. March 1974, 230 pp.

This report presents both a comprehensive long-range program for developing balanced public transportation in Fort Worth and the recommended first phase to implement that plan. The analyses, findings, and recommendations presented address the following three basic questions. (1) What is the proper balance between public and private transportation in the Fort Worth area? (2) Where and what kind of public transportation will be needed? (3) What is the best way to implement these improvements within the constraints of available resources?

Parsons Brinckerhoff Quade and Douglas, Inc. SITE PLANNING AND ROUTE SELECTION: FORT WORTH PARK-AND-RIDE. Prepared for the City of Fort Worth and North Central Texas Council of Goverments. June 1976, 52 pp.

The work of this project consists of two subtasks. Subtask A addresses planning, layout, and cost estimates for the development and implementation of the three previously selected park-and-ride locations. Work includes preparing preliminary engineering plans showing site layout, typical bus shelter design, concept of signs, traffic circulation, and bus routing in and adjacent to the site. Subtask B addresses analysis and selection of optimum express bus routing between the park-and-ride sites and the Fort Worth CBD, development of needed traffic operational improvements for optimum routing, and cost estimates for the associated implementation and operations.

City of Fort Worth Traffic Engineering Department. EXCLUSIVE BUS/CARPOOL LANES FOR THE FORT WORTH METROPOLITAN AREA. February 1974, 207 pp.

In October 1973, the United States Environmental Protection Agency (EPA) set forth guidelines for controlling air pollution resulting from automobiles

and other sources in Fort Worth. Included in the guidelines were requirements for designating exclusive bus/carpool lanes in eight specific traffic flow corridors serving the City's Central Business District (CBD). In addition, three streets within the CBD were required to be identified by the city for providing exclusive bus/carpool service. The investigation of an exclusive bus/carpool lane on each of the eight traffic flow corridors attempted to determine objectively the "effect" that such a lane allocation would have on traffic operations in terms of service levels provided the motorists. In addition, cost estimates were prepared for the implementation of the exclusive lane alternatives in several of the traffic corridors.

North Central Texas Council of Governments. THE TOTAL TRANSPORTATION PLAN FOR THE NORTH CENTRAL TEXAS REGION FOR 1990. October 1974, 242 pp.

This report summarizes the evaluations reviewed by the Steering Committee in developing a proposed 1990 Total Transportation Plan. Included in this report is a description of the approach taken by the Steering Committee, the alternative transportation system concepts which were evaluated, and the projected impacts which were considered. Following these evaluations is the proposed 1990 Total Transportation Plan, as recommended by the Steering Committee.

Shunk AM. et al. REGIONAL TRANSPORTATION STUDY: FINAL REPORT. By Alan M. Voorhees and Assoc., Inc., Barton-Aschman Assoc., Inc., Parsons Brinckerhoff Quade and Douglas, Inc., and Shimek Roming Jacobs and Finklea for North Central Texas Council of Governments, City of Dallas, and City of Fort Worth. February 1974, 219 pp.

The purpose of the Regional Study was to investigate the feasibility of improvements to public transportation throughout the region. In particular, the Regional Study focused on the kinds and costs of possible improvements, determining their general locations and proposing strategies for implementing the improvements. The Regional Study addressed the kinds and levels of financing available, staging and costs of the system, and administrative aspects of regional public transportation service improvement. Detailed study was made of the type of agency which could be responsible for implementing major public transportation facility improvements. Consideration was also given to allocation of responsibilities for operating public transportation services throughout the region.

BUSWAYS

- *Design Considerations*

Corradino JC. BUSWAYS - RAPID TRANSIT FOR AN INTERMEDIATE-SIZED METROPOLITAN AREA. UITP Revue-/Belgium/. 70, v19, n1, pp. 15-19.

A rapid transit system for intermediate-sized areas (those containing one to two million people by 1980) is a possibility; although a fixed-rail system may not be attainable, rapid bus transportation, commonly known as busways, may be attainable. Busways are a relatively new innovation in the field of mass transportation. Essentially, it consists of a network of buses which circulate through residential communities, particularly through the low population-density suburban areas, and then speed over exclusively reserved trunk lines to the focal point of the community, which in most instances is the central business district of the area. A brief description of busway studies made for Atlanta, Boston, Memphis, and Portland is included./Author/

McCaffrey R. Hong H. ANALYSIS OF A FREEWAY BUS TRANSIT SYSTEM. American Society of Civil Engineers Journal, Highway Division. June 1968, v94, nHW1, Procedure Paper 5976, pp. 33-42.

As a partial attempt to relieve the urban traffic congestion, a limited freeway bus transit system has been operating in the Milwaukee metropolitan area. A study of this operation indicates: the system can be initiated at extremely low cost and operated at a profit; the present system has been growing rapidly in popularity and passenger usage; the selection of external terminal points may be made on the basis of the housing densities, parking requirements, and geographical locations; passenger pick-up loops through the external residential areas are helpful in selling the system to prospective users; a quick, yet thorough, distribution loop through the CBD with no need of further transferring satisfies the passengers' needs; and there are several personal characteristics of the passengers that may be used in determining the required service level for the operation./Author/

Barnett J. EXPRESS BUS MASS TRANSIT. American Society Civil Engineers Journal, Transportation Engineering May 1970, v96, n1, TE2, Procedure Paper 7256, pp. 133-148.

A seven-point program for an express bus mass transit system is outlined. The seven points are: fringe parking, transfer areas, terminals, a new bus type, separate ways for express buses, underground operation through dense urban areas, and lower fares. Life in cities can be improved by reducing traffic congestion which requires attack on a broad front, including planning to reduce needed vehicle miles of travel, a freeway system, improvement of arterial streets, and a mass transit system that will result in drivers leaving their cars home. Separate ways for express buses are discussed, particularly separate highways. Roadways below street level through central areas would carry passengers close to employment centers. The development of a dual bus operation to reduce time of travel and cost and to improve the downtown environment is recommended./Author/

Webster FV. PRIORITY TO BUSES AS PART OF TRAFFIC MANAGEMENT. Transportation and Road Research Laboratory (United Kingdom). 1972, R&D Rept N Lr44, 18 pp., 5fig, 3tab, 10ref.

The Transportation and Road Research Laboratory has been studying bus priority schemes, in particular bus lanes, in three ways: (1) controlled test-track experiments, (2) theoretical simulations, (3) studies of actual bus lanes. This paper describes a controlled experiment carried out on the laboratory's test track, and gives some results showing how the saturation flow of cars and the time savings to buses are affected by the position of the end of the bus lane relative to the stop-line. Some information is given on the effect of changing the position of bus bays. This experimental work is extended by means of a theoretical simulation of a bus lane, where different degrees of traffic saturation, together with changes in other variables, are dealt with. Some results of this simulation are given which are compared with the results of the track experiment. The paper goes on to describe a simple theoretical model of an urban area which contains a comprehensive bus-lane network. The results show how the overall costs depend on whether the bus lane operates for peak periods only, or all day. Finally, the paper presents the summarized results of ten actual bus-lane schemes, giving figures for savings in delay to buses, savings or losses to other traffic, and comments on particular aspects of the schemes which were relevant to their success or otherwise./Author/

Rapp MH. Gehner CD. CRITERIA FOR BUS RAPID TRANSIT SYSTEMS IN URBAN CORRIDORS: SOME EXPERIMENTS WITH AN INTERACTIVE GRAPHIC DESIGN SYSTEM. Highway Research Record, Highway Research Board. 73, n455, pp. 36-48, 9fig, 2tab, 7ref.

A man-computer interactive graphic system, developed at the University of Washington, is applied to a series of experiments designed to identify the characteristics of high-performance bus rapid transit systems for CBD-bound riders who reside in a generalized suburban corridor. The solution spaces of 12 problem cases, derived from the combination of several trip demand densities, highway network characteristics, and trip-making behaviors, are explored in an interactive graphic search process. The purpose of the search is to identify optimal solutions using two operator objectives, one maximizing profit and the other maximizing patronage, within a given subsidy constraint. Furthermore, the search is aimed at identifying solutions that cannot be dominated in terms of any combination of patronage and profit, thus forming an envelope in the patronage versus profit-deficit space. From a comparison of these envelopes, some general relationships between bus rapid transit operating characteristics and external conditions are developed. Similarly, relationships between system characteristics and external conditions are derived from a comparison of the penoptimal solutions. Finally, it is shown that the penoptimal solutions may violate some of the environmental, social, or political constraints commonly imposed on public transit systems; and it is demonstrated that, by complying with such constraints, the operator may incur significant losses. /Author/

May AG. et al. Q:S AND Q:S. Operations Research Society of America Bulletin. 67, v15, supp3, pp. B-221.

If a highway system is to be used for both public (buses) and private (cars) transportation, it is often advantageous to give some type of priority service to buses. Since severe congestion is usually confined to only a few critical sections of a highway or to some critical bottlenecks, a priority scheme for service of these bottlenecks could have a significant effect upon the total passenger delay in the entire highway system. Two related types of strategies are considered. First, suppose that on a finite section of a multilane expressway there is a total flow Q and no queue Q at the entrance or exit. If buses are given one or more lanes for exclusive use, it is possible to achieve a higher velocity for buses but a lower velocity for cars than would exist under mixed operation at the same total flow. The higher velocity for buses, each carrying many passengers, will, in many cases, offset the increased delay to car passengers. Second, if a queue does exist at a bottleneck, there are various queue disciplines which might be applied to keep the queue of buses as low as possible, at the expense of the cars. Strategies of first-come-first-served, priority service, and separate service for buses are compared under the condition of a heavy rush-hour demand./Author/

c Wilbur Smith and Assoc. BUS RAPID TRANSIT OPTIONS FOR DENSELY DEVELOPED AREAS. Prepared for U.S. Department of Transportation. February 1975. Government Printing Office Number 050-001-00089, 187 pp.

Effective use of bus transit can reduce pressures for new highway construction in high-density urban areas and the need for additional downtown parking facilities. This report is based on the premise that express bus service has important national applicability. It describes and evaluates alternative bus rapid transit systems by reviewing state-of-the-art, identifying significant options and technologies, as well as assessing cost, service, and community impact. Selected bibliography is included.

Starbuck JC. RAPID BUSWAYS: A CHRONOLOGICAL BIBLIOGRAPHY. Council of Planning Librarians Bibliography. January 1976, n966, 9 pp., 112ref.

This bibliography contains more than one hundred references on rapid busways. They date from 1967 to 1975. Included are such topics as demonstration projects, exclusive bus lanes, feasibility studies, freeway priority system operation, impact on traffic congestion, environmental impact, traffic signs, costs, planning and design guidelines, and contraflow bus lanes.

- *Operations Technology*

Scheel JW. Foote JE. COMPARISON OF EXPERIMENTAL RESULTS WITH ESTIMATED SINGLE-LANE BUS FLOW THROUGH A SERIES OF STATIONS ALONG A PRIVATE BUSWAY. General Motors Research Laboratory. May 1969, Research Publication GMR-888, 28 pp.

Experimental results are compared with the estimated behavior and performance of single-lane bus flow through a series of stations along a private right-of-way. Six buses were driven as a convoy through a series of simulated passenger stations, stopping at each station to simulate the dwell

time associated with stopping for passenger pickup and discharge. The capacities in vehicles per hour observed during these experiments exceeded, in every case, those predicted by the computer program written to study bus motion through such a system. Using buses in groups of six, at a cruise speed of 30 mph between stations 0.3 miles apart, and using a 30-second dwell time, capacities ranged from 350-400 buses per hour and system speeds ranged from 13 to 15 mph./Author/

Herman R. et al. FURTHER STUDIES ON SINGLE-LANE BUS FLOW: TRANSIENT CHARACTERISTICS. Transportation Science. May 1970, v4, n2, pp 187-216.

The results of a series of experiments carried out to determine the transient characteristics of a platoon of buses starting and stopping along an exclusive right-of-way are reported. By using a six-bus platoon on a 2 1/2-mile test facility, the effects of such factors as platform spacing, station spacing, speed, delay, etc. on platoon dynamics were investigated. The space-time trajectories of the lead and last vehicles have been examined in detail and a number of interesting features describing the bus platoon dynamics are presented. In particular, the results indicate that the dynamics of this cyclic operation of starting at one position and stopping at another is highly predictable. The motion of the platoon through such a cycle can be described in terms of a starting transient, a steady state, and a stopping transient, each of which is made up of simple and qualitatively describable features. The experimental observations have been compared with the theoretical results obtained from numerical solutions of the linear car-following model of single-lane traffic flow./Author/

- *Vehicle Technology*

Lobdell NE. GROUPED ROAD VEHICLES-MONOGRAPH NO. 8. Battelle Memorial Institute. October 1967, Project No. Nss-3.

While the grouped- (or articulated-) vehicle concept is familiar in its railway application, little attention has been given to highway applications, such as the tandem bus. Reasons for the failure of previous endeavors are explained, the implications of articulated buses for transit operations are elaborated, and basic issues requiring further research and development are outlined. For the last, schedule and cost estimates are made. NTIS PB 178 250.

Margolis H. A PRELIMINARY EXAMINATION OF MAXIBUSES. Institute for Defense Analysis. July 1970, Project No. Trd-51.

The term "maxibus" is introduced as a generic type of vehicle that embraces both articulated (segmented) and double-decker designs. Anticipated savings from the introduction of maxibuses into present urban transit operations, and in particular applications to optimize cost factors, are examined. The use of large buses in express service and in conventional line-haul on high-volume arteries are contrasted. It is concluded that the economies generated by maxibuses will not be related solely to their increased capacity, and, pending a detailed cost-benefit analysis, savings of not more than 10-15 percent are expected. Systemwide operation of maxibuses would actually be prohibitive. The most promising near-term application of large bus vehicles is commuter express operations. Double-

decker buses are more economical than articulated because of their increased capacity, especially in the recommended commuter express operations. While most past experience with articulated buses has been unfavorable (owing to low ridership), increased demand for express services may restore the attractiveness of large-capacity vehicles in general. Development of reasonably inexpensive and compact automatic fare collection (afc) equipment for buses is 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. Since there is at present no regular United States manufacturer, initial demonstrations of the maxibus concept would have to use European equipment. Appendices contain a state-by-state listing of legal restrictions on motor vehicle length and weight, and advertising and vehicle specifications of neoplan (brand name) maxibuses produced in Germany and marketed in the United States. NTIS AD 711 596.

PROJECT SUPER BUS: SPECIFICATION FOR AN ARTICULATED TRANSIT BUS. Booz-Allen Applied Research, Inc. Urban Mass Transportation Administration, National Transportation Center, Final Report. October 1974, UMTA-PA-06-0007-74-1, 87 pp.

The report is a specification providing a prospective manufacturer with guidelines to develop an articulated bus specifically suited to transit service in the United States. It specifies the basic physical dimensions, passenger accommodations, and propulsion for a series-built multipassenger public service vehicle designed primarily for urban service but with adaptability to arterial and truck line service. The nominal design capacity is for a vehicle having a single operator and a capacity for 70 or more seated passengers, with state-of-the-art propulsion and human factors design. The specifications meet all applicable federal, state, and local safety and performance standards. Chapters discuss vehicle structure, furnishings, driver's station and controls, energy conversion, suspension and guidance (steering), and heating, ventilating, and air conditioning. Appendices contain definitions and abbreviations. NTIS PB-243692/1ST.

PROJECT SUPER BUS: HIGH-CAPACITY BUS CONCEPTUAL DESIGN STUDY. Booz-Allen Applied Research, Inc., Urban Mass Transportation Administration, National Transportation Center, Final Report. December 1974, UMTA-PA-06-0007-74-2, 193 pp.

The purpose of the study was to determine the technical criteria for high-capacity transit buses for United States operation. Principal emphasis was placed on the articulated bus concept, because the maneuverability of articulated buses makes them suitable for service on any route that can be served by a standard 40-foot rigid bus. The double-deck bus concept was also studied because it offers some operating cost advantages, but vertical clearance problems would limit its use to about 30 percent of the high-capacity routes. Design studies were made of a number of specific configurations for the two generic concepts. The objective in the double-deck design studies was to achieve maximum height in the aisle in both decks, while maintaining the maximum number of seats in a conventional arrangement. Information is presented on the market potential and production costs for high-capacity buses. NTIS PB 243 693/9ST.

- *Specific Applications*

Parrish HL (California Department of Transportation). SAN BERNARDINO FREEWAY-BUSWAY-PEOPLE MOVING IN THE L. A. AREA. Metropolitan. July 1974, v70, n4, pp. 10-13.

The California Department of Transportation's goal of creating preferential treatment for high-occupancy vehicles into the center of Los Angeles faster consists of a tri-modal transportation corridor incorporating a freeway, busway, and railroad. Parking lots with "kiss and ride" facilities are provided, as well as a new terminal for buses. The article details the many government agencies involved in the whole project, the division of responsibilities involved, the need for cooperation among the various agencies, and the measures undertaken for noise pollution control. This concept of a bus rapid transit system was untried at the time of its initiation, and the question was whether motorists would leave their cars and use it. The energy crisis proved that people will tolerate many inconveniences rather than leave their cars. Patronage on the busway has increased, but it has also increased on the freeway. An evaluation of the busway is being done by a consulting firm which will involve experimenting with controlled freeway access for carpools, and exclusive bus use of the busway to elicit public reaction. At this time, the two goals of higher vehicle occupancy and greater use of the freeway which created the San Bernardino Busway are also making it work effectively.

Gallagher R. TRANSIT FEATURES OF PROPOSED SAN BERNARDINO CORRIDOR EXPRESS BUSWAY PROJECT. Institute of Traffic Engineers, University of California at Berkeley, 23rd California Transportation and Public Works Conference. March 1971, pp. 23-24.

For the first two years of a five-year test period, busway flyers will have exclusive use of the two lanes to be added to the freeway. In the third year, automobiles may be metered into the bus lanes at the El Monte end, at the midpoint station, and just east of the Long Beach Freeway, up to the point where the autos fill the gaps between buses, but not to the extent where they cause any significant reduction in bus speeds. Prior to the end of the third year, the federal and state agencies involved will reach a decision as to the method of operation during the last two years of the five-year period. The primary purpose of this project, developed by the Southern California Rapid Transit District, is to increase the people-carrying capacity of the San Bernardino freeway corridor. The impact of the project on the physical setting, on other transportation modes, in relation to passenger comfort and safety, and as a test of a concept, is considered.

Gallagher R. PROPOSED EXCLUSIVE-EXPRESS BUSWAY IN AND ALONG THE SAN BERNARDINO FREEWAY BETWEEN LOS ANGELES AND EL MONTE. Institute of Traffic Engineers, 39th Annual Meeting. August 1969, 14 pp.

The Southern California Rapid Transit District (SCRTD) operates some 1500 buses in four counties of this metropolitan area. The Los Angeles metropolitan area may look forward to having the world's first exclusive-express busway. It is proposed that this express busway be approximately

12.4 miles in length between Santa Anita Avenue in El Monte and the Los Angeles Civic Center. The trip will take approximately 18 minutes (including station stops), which will yield an average speed of approximately 41 miles per hour. Maximum bus speed will be just under 60 mph. These buses will stop only at certain express stop locations. This project hopes to initiate high-speed rapid transit service within the SCRTD at the earliest possible date. It is hoped to demonstrate to the public the convenience and advantages of rapid transit service over a route that has been plagued with peak hour congestion. Peak hour passenger volumes in the peak direction at the peak road point on the busway have been estimated to be approximately 4000 persons per hour. This exclusive-express busway would be the equivalent of adding two additional lanes to each side of the San Bernardino Freeway between El Monte and the Civic Center. Construction work involved and cost and time estimates are reported.

Crain JL (Bigelow-Crain Assoc.). EVALUATION OF A NATIONAL EXPERIMENT IN BUS RAPID TRANSIT. Transportation Research Record. 75, n546, pp. 22-29.

An extensive evaluation is being performed of a bus rapid transit system in Los Angeles that uses exclusive bus lanes in the median strip of a freeway. This national experiment is currently quite successful. Operational feasibility has been demonstrated, and the number of busway system riders has continuously grown over the first 18 months of operation even though the facility is only partially operational. The new riders are former automobile users, and their socioeconomic profiles are more similar to automobile commuters than to bus commuters. Assuming that car occupancy is only 1.3 persons/vehicle, the busway system has at least a tenfold greater capacity (per traffic lane) than the highway system. However, the busway lanes during peak periods currently carry only about half of the person trips that are carried by a freeway lane, but are catching up fast. The principal causes for travelers switching from automobile to busway commuting, based on survey results, are to save travel time and to avoid the frustration of the stop-and-go characteristics of a congested freeway.

McQueen JT. et al. THE SHIRLEY HIGHWAY EXPRESS BUS-ON-FREEWAY DEMONSTRATION PROJECT/A STUDY OF PARK-AND-RIDING. National Bureau of Standards, Urban Mass Transportation Administration (NBS-4314552) Interim Report. March 1975, NBSIR-75-689, #6, Contract DOT-AT-40018, 52 pp.

The project-promoted park-and-ride operations on the Shirley Highway led to sizable increases in bus patronage. Park-and-riders, commuters who traveled by auto to a bus stop and then by bus to work, greatly expanded the market for the fixed route bus service in the Shirley Highway Corridor area. The report presents results of a study of the successful park-and-ride operation within the Shirley Highway Corridor area: suburban fringe parking lots coupled with the high-speed buses of the Shirley Highway Express-Bus-on-Freeway Project. Demographic characteristics of the park-and-riders, as well as characteristics of their present park-and-ride and previous commuter trips, are examined. Factors important in the commuters' decisions to park-and-ride are identified. The report also describes the survey procedures used. NTIS COM-75-11190/6ST.

Taylor JG. RESERVED LANES FOR BUSES: THE SHIRLEY HIGHWAY EXPERIMENT. Institute for Defense Analysis. June 1970, Project No. Trd-51.

Such priority schemes as reserved lanes for commuter buses can assist in reducing traffic congestion on major metropolitan highways and increasing the productivity of the transit system. Exclusive bus lanes are being tried out in several cities. The evolution of the Shirley Highway Project (initial planning, implementation, and administration) is examined prior to analysis of specific aspects of the demonstration, beginning with possible driver reaction to the exclusive busway. Initial motorist reaction had been slight, but possible adverse reactions and countermeasures can be anticipated. Potential litigation against reserved busways is examined, with reference to the use of public tax revenues to give priority to private transit carriers, and the possibility that chartering of the reserved lanes exceeds the authority of the Virginia Commissioner of Highways. Countermeasures and palliatives to reduce adverse driver reaction and political pressure are suggested. Data collection methods for before-and-after studies of the busway experiment are recommended in the areas of traffic counts on the highway, traffic volume in the adjacent area, truck traffic, auto occupancy, travel time, and ridership characteristics. As a fundamental objective of the Shirley Highway experiment is to reduce the volume of commutation by private automobile in the Washington, D. C. area, it is recommended that incentives to increase automobile productivity be combined with disincentives for overall automobile usage: the former through strict regulation of downtown parking by increased costs and reduced availability. The capital and equipment requirements to satisfy project demand for commuter bus service are estimated. NTIS AD 708 019.

URBAN CORRIDOR DEMONSTRATION PROGRAM MANHATTAN CBD-NORTH JERSEY CORRIDOR, JOINT USE PARK-AND-RIDE. New Jersey Department of Transportation, Federal Highway Administration, New Jersey Turnpike Authority, Port Authority of New York and New Jersey, Tri-State Regional Planning Commission Final Report. February 1975, Contract DOT-FH-11-7778, 37 pp.

The report summarizes the work performed for one of the five projects conducted in the Manhattan CBD-North Jersey Corridor under the Urban Corridor Demonstration Program. Information is given concerning the methods used to attempt a successful demonstration of the concept of using parking lots used for other activities as park-and-ride sites. Types of facilities investigated include shopping centers, drive-in theatres, and factories. Requirements for joint use park-and-ride facilities were determined and are presented. NTIS PB 244 475/OST.

BLUE STREAK BUS RAPID TRANSIT DEMONSTRATION PROJECT. Alan M. Voorhees and Assoc., Inc., Seattle. Interim Report. July 1972, UMTA-WASH-Mtd-2-72-2, 157 pp.

Survey results and other data collected during Phase II of the Blue Streak bus rapid transit demonstration project in Seattle, Washington are presented. The purpose of this project is fourfold: (1) evaluation of the transit patronage which can be generated by rapid transit bus service operating partially on exclusive rights-of-way; (2) establishment of a warrant for reserved freeway lanes and/or ramps for such exclusive bus

use; (3) evaluation of the sensitivity of potential transit users to improvements in transit service; and (4) evaluation of the "change of mode potential" by studying the operation of a park-and-ride facility in conjunction with bus rapid transit service. The Blue Streak service operates in a major high-density CBD access corridor on the I-5 freeway. A major feature of the service is exclusive bus use of a key reversible ramp connection between I-5 and the CBD. Under Phase II of the Blue Streak project, traffic and travel surveys were conducted and analyzed. This report contains a brief chapter highlighting significant aspects of the Phase II-Phase I relationship, followed by analysis of economic and general travel pattern trends, survey comparisons in greater detail, and operational aspects of the bus rapid transit service. The various appendices present detailed tabulations of the Phase II-Phase I comparisons, plus details about trends and transit operations. NTIS PB 218 879.

Mayer HM. CHANGE OF MODE COMMUTER TRANSPORTATION IN METROPOLITAN MILWAUKEE. Highway Research Circular, Highway Research Board. n83, 12 pp.

The Milwaukee and Suburban Transport Corporation operates two rapid transit bus routes, making use of existing freeway roadways as the means of rapid travel. Both facilities are park-and-ride, making use of outlying parking lots made available by privately owned shopping centers. The routing and service of these rapid transit bus lines are reviewed. These services indicate that standard city buses can operate freely and without hindering other traffic on city freeways. Buses operated on the freeway can operate as fast as automobile traffic, and, when taking parking time into account, may provide a faster door-to-door service than the automobile itself. Passengers are willing to change mode, transferring from an automobile to a bus in commuting to downtown. However, they do not appear to be as willing to transfer from one transit vehicle to another. Increased use of shopping center parking results in increased business for the shopping centers. It is concluded that bus rapid transit making use of existing freeways can be financially successful and can convert auto drivers to bus riders.

THE METRO FLYER. A SUBURBAN BUS SERVICE TO DOWNTOWN, TOWSON AREA, BALTIMORE COUNTY, BALTIMORE CITY, MARYLAND. Maryland Metropolitan Transit Authority. 67, 29 pp.

An investigation was conducted into the practicability of providing a suburban, low density, high income residential area with express bus service to the downtown shopping, recreational, and employment center. The Towson, Maryland residential area and its several adjacent suburban areas (combined population in excess of 19,000) were provided with modern, air-conditioned express bus service to the central business district of Baltimore City, using limited access highways for approximately 72 percent of the one-way trip. Service was coordinated with the principal hours of employment, and timely trips were provided for shoppers. Included in the project were provisions for free parking facilities, an adequate promotional campaign, and a data collection program that would yield information of value to other communities contemplating similar express bus service programs. The project bus service operated as a demonstration program for one year. During this period, passenger usage

increased by 193 percent over the first month of operation and, at the close of the project period, the Metro Flyer was transporting an average of 496 passengers per day. The great majority of transit trips were peak hour, work-oriented trips. The service was continued, with minor modifications, by the private carrier after the close of the experiment at a profit to the carrier./Author/

BUSWAY AT REDDITCH. Traffic Engineering and Control/United Kingdom/. July 1971, v13, n3, p. 117.

The Department of the Environment will be paying a 75 percent grant toward the 1.25 million pounds sterling construction cost for the first three miles of Redditch's bus-only road system. The new town's "Busway" will involve the construction of seven miles of new road at a cost of about 2.8 million pounds sterling, and later the adaptation of up to eight miles of existing roads at a further cost of about 800,000 pounds sterling. One section of the busway has already been completed, and three miles will be operational by 1974. It is expected that, eventually, some 30 buses will operate on the full circuit at peak hours, each carrying up to 60 passengers at an average speed of 30 mph, with stops about one-third of a mile apart./Author/

LIGHT RAIL TRANSIT

- *Role of LRT*

Vuchic VR. PLACE OF LIGHT RAIL TRANSIT IN THE FAMILY OF TRANSIT MODES. Transportation Research Board Special Reports. 75, n161, pp. 62-76.

The paper attempts to clarify concepts and terminology of urban transit systems. Modes are defined by type of right-of-way, system technology, and type of service and operation. Right-of-way is shown to be the most important single feature determining mode performance and cost. Advantages of partial or full separation of transit from surface traffic are defined. The basic features of system technology are analyzed. Guided systems are compared with driver-steered systems; rail systems are compared with rubber-tire guided systems; and manually driven systems are compared with automated systems. With respect to operations, it is pointed out that commuter transit should be a supplement to, not a substitute for, regular transit. An analysis of optimal vehicle size shows that, for guided systems that are in use or may be operational in the near future, minimum vehicle capacity should be 40 to 50 spaces. Based on this analysis of mode components, it appears that potential light rail applications are in medium-sized cities as carriers serving major routes and in large cities as a supplement to rapid transit. In large cities with low densities, light rail transit or light rapid transit also has potential for application. Small cities and special services may sometimes also use this mode. The following rights-of-way are best suited for light rail: street and highway medians, railroad rights-of-way, aerial structures, and, in downtown areas, short tunnel sections.

Orski CK (Urban Mass Transportation Administration). THE URBAN MASS TRANSPORTATION ADMINISTRATION VIEW OF LIGHT RAIL TRANSIT. Transportation Research Board Special Reports. 75, n161, pp. 14-15.

This paper addresses the issues of how the Urban Mass Transportation Administration views light rail transit, what future role UMTA sees for this technology in American cities, and what considerations led UMTA to sponsor a Light Rail Transit Conference. Although UMTA recognizes the virtues of the light rail concept, it does not see this as a panacea for urban mobility problems. It is believed that light rail may be a major solution to the search for less costly, more efficient, and more environmentally attractive transportation systems that can economically serve the dispersed land-use and travel patterns of metropolitan areas.

Herringer FC (Urban Mass Transportation Administration). LIGHT RAIL TRANSIT: AN URBAN TRANSPORTATION ALTERNATIVE. Transportation Research Board Special Reports. 75, n161, pp. 16-18.

The Urban Mass Transportation Administration expects federal policy for investment in major urban transportation projects to lead to a rational allocation of limited resources. This is not a new concept, and analysis on the basis of cost effectiveness by both federal and local agencies should encourage more cities to consider light rail as an alternative. Light rail on exclusive right-of-way can be an attractive competitor to

the automobile.

Kizzia T. WATCH FOR A BOOM IN LIGHT RAIL. Railway Age. August 1974, v175, n15, pp. 16-21.

Cities too small for full-scale rapid transit (at the present), yet too big to rely on buses alone, are discovering an intermediate alternative. Proponents of light rail transit claim that, properly separated from street traffic on its own right-of-way, it is less expensive to build than full rapid transit, and can do twice the job of a stream of buses at a smaller operating cost. Three boom towns in western Canada - Vancouver, Edmonton, and Calgary - are planning such lines. A number of middle-sized United States cities - Portland, Dayton, Rochester, Fort Worth, Austin, San Diego, and Phoenix - are studying the use of light rail. Boeing is building a standard light rail vehicle to replace aging streetcar fleets in Boston and San Francisco. This vehicle can carry 10,000-12,000 passengers an hour running at two-minute intervals.

Vigrass JW (Port Authority Transit Corporation). PHYSICAL, OPERATIONAL, AND PERFORMANCE CHARACTERISTICS OF THE LIGHT RAIL MODE. Transportation Research Board Special Reports. 75, n161, pp. 19-25, 5ref.

An overview of the light rail mode is presented. General characteristics and application of the mode are described, emphasizing the versatility of its guideway, the railway track. Physical characteristics of the right-of-way and ranges of dimensions for right-of-way and vehicles are discussed. Stations are discussed briefly. Basic technical simplicity of the light rail mode is pointed out as a significant virtue. Operating characteristics (both maximum running speeds and typical average operating speeds) are indicated. Acceleration of typical vehicles is noted. Frequency of service is discussed, and ranges for various traffic control systems are given. Riding quality and visual impact are pointed out as being favorable. Capacity of light rail lines is given as a few thousand to 12,000 passengers per hour. In special cases, a high of 18,000 passengers per hour can be achieved by using multiple-unit trains of three or more cars. Choices of a designer to attain maximum capacity are stated. Capital costs of contemporary new light rail systems are given as ranges of costs for various configurations. It is concluded that light rail transit is a medium-cost mode providing a medium level of capacity at medium speeds that can find application in many corridors or areas in medium- and larger-sized urban areas. It is pointed out that light rail is an existing mode with proven capabilities that needs little or no new research and development.

Tennyson EL (Pennsylvania Department of Transportation). PUBLIC CONSIDERATIONS OF THE ECONOMICS AND MARKETING OF LIGHT RAIL TRANSIT. Transportation Research Board Special Reports. 75, n161, pp. 167-172.

The term light rail transit is defined for its use in this paper. This paper is concerned with that type of rail transit that permits electric operation of rail vehicles, singly or in trains, and is capable of subway, elevated, at-grade, and in-street operation on any given route. Economics and marketing are related in the same manner that revenue and

expense are related. Adaptation of the service to maximize public response cost will confer public benefits to both the user and the taxpayer when more costly alternatives are relieved or avoided. The unique aspects of light rail transit in developing and conferring benefits are reviewed and analyzed. Light rail transit is often less costly and more convenient than full-scale rapid transit; it is often more efficient, attractive, and economical than conventional bus transit within its proper area of operation.

Taylor SF (Sanders and Thomas, Inc.). ANOTHER ALTERNATIVE: THE CASE FOR LIGHT RAIL, PART I. Transit Journal. May 1975, v1, n2, pp. 15-34, 3fig, 13ref.

The objectives of providing better mass transit through conventional means (bus, heavy rail transit, and personal rapid transit) are examined, and the possibilities of increasing system efficiency by incorporating light rail rapid transit into the overall plan is explored. A discussion of the physical characteristics of light rail covers aspects of the vehicle, the operator, fare collection, design criteria and standardization, right-of-way, stations, controls, and communication. Light rail's basic characteristic is versatility, and it can be used effectively in: basic service supplemented by bus; supplement to high capacity rapid transit; rapid transit feeder service; high-speed suburban service; and short haul intercity service. Light rail's capability to meet fluctuating traffic demand is discussed and comments are made on light rail as an instrument for integrated public transportation.

- *Inventory of Existing LRT Systems*

Taylor SF (Sanders Associates, Inc.). LRV: A WORLD OVERVIEW. Mass Transit. June 1975, v2, n6, pp. 7-9, 10phot.

The light rail transit mode is defined (as an evolutionary mass transit mode based on established technology which offers a variety of services and an effective means to control operating costs); its successful operation in many cities (212 in 35 nations) is noted; and the most common approach to its establishment (upgrade existing street car systems by tackling fixed facilities and vehicles) is outlined. The removal of trollies and substitution of buses, the survival of the streetcar in European cities, the automated rapid rail and personal rapid transit systems, the ease of negotiation of 5 or 6 percent grades by light rail vehicles, and total route segregation in some cities are briefly reviewed. Vehicle technology for this system of transportation is outlined. Longer vehicles which offer high passenger/driver ratio may be utilized.

Taylor SF. URBAN TRANSPORTATION - ANOTHER ALTERNATIVE: A WORLD-WIDE SURVEY OF LIGHT RAIL TECHNOLOGY. Heritage Foundation, Inc., Public Policy Studies #10. 1974, 55 pp.

Light rail transit is intermediate between bus transit and full subway rapid transit. Light rail transit has higher capacity and speed than bus and lower capital cost than full subway rapid transit. This report surveys the use of light rail transit around the world, compares light rail

transit to both bus transit and full subway rapid transit, and highlights the advantages of light rail transit.

PERSPECTIVES FOR LIGHT RAPID TRANSIT IN BRITAIN. Railway Gazette International (England). May 1974, v130, n5, pp. 185-188.

Because more than 20 years has elapsed since tramway development in Britain ceased, industry has had to draw on experience from abroad to meet the newly-expanding demand for light rail technology. Two prototype cars now taking shape for Tyneside provide a testbed, not only for that network, but also for other light railway and tramway schemes now being studied. The favorable prospects for light rapid transit in Britain can be attributed in part to the overall swing in favor of public transport, in part to the interest in lightweight fixed track systems generated by the various PRT studies, and in no small measure to the progress made by the Tyneside (now Tyne and Wear) Passenger Transport Executive in achieving and making known its objectives.

Rogers LH (Institute of Public Administration). LIGHT RAIL TRANSIT: 1975 USAGE AND DEVELOPMENT. Transportation Research Board Special Reports. 75, n161, pp. 7-13.

A worldwide survey of light rail transit systems and specific details of many of these operations are included. General principles of the application of light rail technology are derived from some of these applications. The author notes that the design and subsystem components for the guideway, as well as the power distribution technology, exist presently. The vehicle necessary to implement this technology is currently in design or is being manufactured in Belgium, Germany, Switzerland, Canada, and the United States.

Middleton WD. GETTING READY FOR THE MUNI METRO. Railway Age. June 1975, v176, n11, pp. 26-32, 2fig, 1phot.

Major events and factors crucial to the San Francisco Municipal Railway System are described. This system, which will integrate urban and regional transit networks, will have a fleet of 55-mph light rail vehicles and a brand new or largely rebuilt, largely grade-separated rail system that will permit reductions in overall running times ranging from a third to nearly half. The retainment and requirement of five heavily used street railway lines operating in the city's principal thoroughfare, and the new BART-built Market Street (principal thoroughfare) subway are seen as key elements in the development of the municipal railway system. Surface improvements provided for by the system are described. An innovative feature for the upgrade program for existing trackage was the establishment of a reserved median strip for rail lines in place of trackage in paved street areas. The construction of a new shop facility and the new fleet of 100 articulated Boeing-Vertol cars are briefly described. The gradual and carefully tested introduction of the Muni and its integration with the regional BART system are outlined.

- *LRT Design and Operation*

Sullivan BE (British Columbia Department of Municipal Affairs). ROUTE LAYOUT PHILOSOPHY AND SERVICE COORDINATION PARTICULARLY FOR LIGHT RAIL TRANSIT. Transportation Research Board Special Reports. 75, n161, pp. 26-36, 1fig, 1tab, 20ref.

Peak-period and all-day service in public transportation are discussed, with emphasis on light rail transit. Peak-period service treats each line as a separate entity operating from residential neighborhoods directly to the central business district. This type of service is typified by the American metro-mode motor-bus concept. Each route in an all-day service interacts with every other route, enabling regionwide mobility. This integrated approach is found throughout Europe and is also well developed in a few United States and Canadian cities. Traditional network arrangements, such as radial and grid setups, and more recent concepts, such as the timed transfer local point, are considered. Detailed aspects of service integration, including schedules, passenger facilities, information, and fares, are reviewed. A widespread disinclination in North America to implement integrated systems exists because of limited funds, and management disinterest is noted. The organizational structure successfully adopted in Europe to bring about service integration is described.

Landgraf RJ (Ohio Department of Transportation). LIGHT RAIL PERMANENT-WAY REQUIREMENTS AND SOURCES. Transportation Research Board Special Reports. 75, n161, pp. 77-85, 9ref.

This paper sets forth the technical requirements for the permanent-way needed in construction of light rail transit facilities and then develops sources for assembling rights-of-way. Described first are the physical capabilities of light rail transit for grade, curves, and clearances. Requirements for the guideway are established with the development of standards for track work suited to light rail transit. The latest techniques in track component design are evaluated. Pitfalls to be avoided in light rail facility design are pointed out. General requirements for stations are set forth with particular emphasis on space needs. Types of platforms, shelters, and security enclosures are described. Station needs for light rail transit are contrasted with the needs of full-scale rapid transit. Sources that can be considered for light rail rights-of-way are treated in a way intended to stimulate the imagination of the engineer and planner in locating potential routes. Dealt with are surplus railroad tracks, boulevard and freeway center strips, canal beds, stream channelization, electric transmission lines, parkways, street running, reservation of streets, and the selective application of elevated lines, bridges, and subways to light rail transit. Advantages and limitations of each type of right-of-way are explained.

Thompson GJ. LIGHT RAIL TRANSIT SOCIAL COSTS AND BENEFITS. Transportation Research Board Special Reports. 75, n161, pp. 147-158.

This paper identifies the social aspects of light rail transit and categorizes them according to the viewpoints of the rider, those on the

wayside, the community, and the contributor of capital funds. The physical characteristics and service qualities of light rail transit accumulate to provide benefits that are judged to outweigh the social costs. Highlighted is the light rail transit attribute of serving a greater number of persons' travel needs through extensive distance covered for a given investment, frequent stations, easy access, and short door-to-door travel time. The ability of light rail transit to condense the amount of time between ground breaking and operation of service is stressed. This is credited to simpler construction enabled by need for narrower rights-of-way, use of sharper curves and steeper gradients, and tolerance of grade crossings. The ability of light rail transit to evolve at a later date, through additional investment, into conventional rapid transit is acknowledged. The paper draws conclusions from a 1960 study in Frankfurt, Germany that served as the springboard for the now extensive development of light rail transit networks throughout Europe. Instances of specific social aspects are cited.

Parkinson TE. LIGHT RAIL TRANSIT SYSTEM EVALUATION. Transportation Research Board Special Reports. 75, n161, pp. 159-166.

Evaluation of a light rail transit system involves many considerations that are specific to sites or systems and cannot be treated in a general study. However, it is possible to establish a value for reductions in running time relative to reductions in direct operating cost, savings in passenger time, and increases in net system revenue. These values, which depend on passenger volume, can be related to capital cost improvements. These include eliminating on-street running, eliminating grade crossings, instituting high-platform loading, and varying fare-collection systems. Brief commands are included on other factors of system evaluation including reliability, safety, and provision for future growth. The paper concludes that, although certain intensive improvements are likely to be justifiable, these must depend on a more detailed system-specific evaluation. In general, it suggests that the planning and design of light rail transit should keep the system as simple as possible and, on the surface, avoid automatic application of rapid transit or railroad standards and costs.

Korach RS (Port Authority Transit Corporation). OPERATING A LIGHT RAIL SYSTEM. Transportation Research Board Special Reports. 75, n161, pp. 111-114.

The most important parts of a transit operation -- movement and control of vehicles -- are discussed. Scheduling and control of trains in a hypothetical system are described. Examples of movement and control in light rail systems in Boston, Newark, Shaker Heights, and Cleveland are given.

DeGraw R (Southeastern Pennsylvania Transportation Authority). OPERATING AND MAINTENANCE COSTS OF LIGHT RAIL TRANSIT. Transportation Research Board Special Reports. 75, n161, pp. 122-125.

This paper explains the costs of operating light rail lines, and it explains how light rail can be more economical than other modes under certain

conditions. Using three recent studies of proposed light rail lines as examples, the paper shows that new lines can be economically constructed and operated with a potential ridership of as little as 20,000 daily passengers. The self-service fare systems used on European light rail lines are explained, and an opinion is given recommending that such a system could be implemented on new light rail lines built in the United States. Relatively fixed maintenance costs, high passenger-to-operator ratios, and multiple-unit capabilities make traffic increases on light rail lines much more economical to accommodate than on bus lines. The paper details how light rail lines have high passenger carrying capabilities (as much as 20,000 passengers per day) to economically justify implementation and still have sufficient revenue to cover all operating costs. Also discussed are the ease of implementation, the versatility of the mode, and passenger acceptance and preference.

Touton RD, Jr (Louis T. Klauder and Associates). ELECTRIFICATION AND CONTROL SYSTEMS FOR LIGHT RAIL SYSTEMS. Transportation Research Board Special Reports. 75, n161, pp. 86-92.

This paper provides a broad overview of available electrification and control system technologies for new light rail systems. It is intended for groups with widely diverse backgrounds ranging from city planners to economists and, consequently, does not deal with detailed, specific, and technical design parameters. The portion on electrification is subdivided into sections on power generation, distribution, and collection on the light rail vehicle. The portion on control systems is broader and is divided first into propulsion control on the vehicle and then into systemwide operational control features that are further subdivided into sections on control of the vehicle, control among a number of vehicles, control as a central status reporting area, and automation. The paper concludes with general recommendations for a typical light rail system but recognizes that conditions might require additional or fewer optional features. This is done to emphasize the flexibility and adaptability of light rail systems.

Silien JS. Mora JG (Urban Mass Transportation Administration). FOREIGN LIGHT RAIL VEHICLE DEVELOPMENT. Transportation Research Board Special Reports. 75, n161, pp. 93-98.

This paper begins with a brief description of how the light rail mode has been developed in several West European countries. The basic features of the light rail vehicle, how the vehicle was derived from the streetcar and the subway, and the development of the President's Conference Committee attempts at standardization of light rail vehicles in West Germany after World War II are discussed. Several modern light rail vehicles are described, and the proposed Canadian light rail vehicle is described.

Beetle GR (Louis T. Klauder and Associates). LIGHT RAIL TRANSIT CONSTRUCTION COSTS. Transportation Research Board Special Reports. 75, n161, pp. 115-121.

Light rail transit has attractive service characteristics that can be

secured in most cities for modest investments. The relatively low construction costs of light rail transit are due primarily to avoiding large civil works by relying instead on reserved rights-of-way at grade. Many options are available for alignments at grade, and costs for way reservation can vary widely. This paper describes the construction costs for modern light rail transit; it takes into consideration way reservation and the more predictable costs for stations, street crossings, track, cars, electrification, signals, communications, and other requirements. The costs presented are estimates, based on the experience of the author on recent evaluations of light rail transit for several United States cities. Few new light rail facilities have been built in the United States in recent years; therefore, little opportunity exists for relating estimates of this type to actual construction. Figures discussed here range from high to low where convenient, and single estimates presented are conservative representations of the largest values likely to be experienced in most cities.

Jessiman WA (Cambridge Systematics, Inc.). Kocur GA. ATTRACTING LIGHT RAIL TRANSIT RIDERSHIP. Transportation Research Board Special Reports. 75, n161, pp. 126-146.

This paper addresses the complex planning considerations for attracting ridership to transit systems, particularly light rail transit systems. Taking the viewpoint of a potential rider, the authors present some observations that lay the foundation for understanding ridership response. Users are not interested in technology per se but in the level-of-service the system provides. Level-of-service is a complex combination of many system attributes, such as travel time, cost, comfort, and convenience. Different user groups (market segments) make different trade-offs among these attributes. They assign different relative weights or importance to each attribute. To attract maximum ridership, the system should be tailored to the particular needs and constraints of the market segments it is serving. No single system is superior for all market segments. The paper discusses the various level-of-service attributes and their relative importance to different market segments based on empirical evidence and attitude surveys. Although one cannot generalize because different market segments assign different relative weights to level-of-service attributes, the following rank ordering of attributes from most influential to least influential is most typically the case: out-of-vehicle travel time, in-vehicle travel time, cost, comfort, and safety. For work trips, travel time reliability should be added as either the first or second most important attribute. The characteristic convenience is dismissed from this list as being too broad to be specifically and universally defined. The paper goes on to introduce disaggregate, behavioral, travel-demand models as an emerging analytical technique that the transit planner can use to more precisely address the problem of the ridership response of different market segments to different level-of-service packages. Examples of these models are then used to demonstrate how different prototypical households would respond to various technologies under various representative operating policies. Some conclusions are drawn on the situations in which light rail transit would appear to be the most attractive form of public transportation from the rider's point of view, and some suggestions are made on how to improve attraction

of light rail transit ridership.

Diamant ES. et al (DeLeuw, Cather and Company). LIGHT RAIL TRANSIT: STATE-OF-THE-ART REVIEW. Final Report. Spring 1976, Report No. DOT UT 50009, 297 pp.

Operational experience in cities of Western Europe and North America suggests that light rail is a viable transit alternative for United States cities as well. This state-of-the-art review seeks to establish a common level of understanding of light rail transit among planners, community leaders, and decision makers. Contemporary planning concepts of light rail are reviewed and a description is provided of guideways, stations, hardware, operations, and costs. The report examines the developmental trends of the last two decades which caused the renaissance of light rail in some western countries. The review focuses on the range of transit services offered by light rail, the utilization of a range of right-of-way opportunities along its routes, the lower investments, and the potential for staged deployment associated with this mode.

Diamant ES. et al (DeLeuw, Cather and Company). LIGHT RAIL TRANSIT: STATE-OF-THE-ART REVIEW. Executive Summary. Spring 1976, Report No. DOT UT 50009, 61 pp.

Operational experience in cities of Western Europe and North America suggests that light rail is a viable transit alternative for United States cities as well. This state-of-the-art review seeks to establish a common level of understanding of light rail transit among planners, community leaders, and decision makers. Contemporary planning concepts of light rail are reviewed and a description is provided of guideways, stations, hardware, operations, and costs. The report examines the developmental trends of the last two decades which caused the renaissance of light rail in some western countries. The review focuses on the range of transit services offered by light rail, the utilization of a range of right-of-way opportunities along its routes, the lower investments, and the potential for staged deployment associated with this mode.

RAIL RAPID TRANSIT

- *Existing RRT Systems*

Wohl M. ANALYSIS AND EVALUATION OF THE RAPID TRANSIT EXTENSION TO CLEVELAND'S AIRPORT. Highway Research Record, Highway Research Board. 72, n417, pp. 12-24.

During the late 1960's, one of Cleveland's two rapid transit lines was extended four miles to the airport. Two of the three new stations, including the one at the airport, were opened in November 1968, while the third was opened in April 1969. The total capital outlay for the extension, including stations, was $18.4 million, of which rolling stock accounts for $3.4 million. The present report is based on three full years of operational experience. Because of the nature of the data on which they are based, the conclusions are considered tentative. The major topical headings are: the effect of extension on rapid transit ridership, financial feasibility of the extension, economic feasibility of the extension, external benefits and costs, effect on traffic congestion, and implications for other airport extensions. The principal findings and concluions are the following: (1) the incremental costs for the extension are 63-163 percent greater than the incremental revenues received from its new riders; i.e., a deficit of $0.7-$1.2 million per year; (2) there is little likelihood of reducing the deficit; (3) assuming a stable ridership, fares would have to be raised 20-32 cents to break even, a 40-60 percent increase; (4) only about 14 percent of air passengers, or 2000 persons, use the extension daily; (5) about 8000 other passengers use the extension daily, an insufficient number for a high-capacity rail system; (6) the extension appears to have removed at most 125 vehicles per lane from the most congested Cleveland expressway during the peak hour, a reduction of less than 10 percent and a time savings, over the length of the extension, of about 30 seconds; and (7) the extension is used chiefly by persons considerably more affluent than most Cleveland residents. It is recommended that other cities contemplating such extensions should (1) conduct good feasibility studies in advance of the improvement program and (2) study carefully the equity questions that arise from expenditure of public funds for such projects.

Ihnat G. CLEVELAND TRANSIT AND PARKING OPERATIONS. Highway Research Circular, Highway Research Board. January 1969, n91, 27 pp.

The Cleveland Transit System, a municipally owned operation, provides urban transportation service in the city of Cleveland, Ohio and 41 adjacent communities. The system is a completely grade-separated, high-level platform rail operation constructed on mainline railroad right-of-way. There are 78 motor coach routes with 21 branches which are operated over 714.5 miles of regular service. The rapid transit system operates over 14.92 route miles. In addition, 181.8 route miles of special bus services are operated, providing special service to schools and industrial plants. Feeder bus service is provided to the 14 rapid transit stations. Kiss-and-ride and park-and-ride facilities are provided. More than one and one-half times as many people are now carried across the Cuyahoga River on the rapid transit over one track in peak hour travel time as

are moved by automobiles. The travel time of passengers is reduced by half. The parking areas, passenger protection, loading platforms, and terminals are described. Based on 12 years of experience, the Cleveland rapid transit operation has clearly demonstrated the widespread need for these transit facilities.

CLEVELAND SHOWS THE WAY. . .AIRPORT EXTENSION WILL SOLVE JET AGE PARADOX. Metropolitan. September 1968, v64, n5, pp. 20-24.

The Cleveland Transit System is completing the building of the four-mile rapid transit extension from its West Park Station to Cleveland Hopkins International Airport. When the extension is opened in November 1968, running time to the airport from downtown Cleveland, the hub of the rapid transit line, will be 20 minutes. In comparison, the trip by car takes about an hour in rush hours. The airporters, the first rapid transit cars designed specifically for passenger service between a metropolitan airport and the downtown business district, are built of stainless steel and are capable of traveling up to 60 mph. The seats are wider than in the present CTS rapid transit cars and are spaced farther apart for added passenger comfort. Each car is equipped with two luggage racks to accommodate the airport traveler. The trip from the airport to downtown Cleveland will cost 35 cents./Author/

Wiggers GF. CLEVELAND RAIL TRANSIT AIRPORT SERVICE. Highway Research Record, Highway Research Board. 70, n330, pp. 21-24.

The study reported is organized around the extension of the Cleveland Transit System (CTS) rail rapid transit line to Hopkins International Airport. An objective in this study has been to develop the means to make accurate forecasts of transit demand as a supplementary mode for airport access, based on the empirical data and experience in Cleveland. The rail rapid link to the Cleveland Airport represented a unique opportunity for such a project; it is the only direct connection of a rail rapid system to a major airport in the United States and was only made possible through a federal grant under the Mass Transportation Act of 1964. To the extent that grant applications for similar extensions may be made in the near future and because of the Department of Transportation's responsibility for coordinating and promoting interstate transportation, this study will have a direct application in policy decisions of the department. It will also provide some valuable information that can be used on the state and local levels for regional transportation planning./Author/

Boyce DE. Murthy BV. ANALYSIS OF PEAK PERIOD PASSENGER FLOWS ON THE LINDENWOLD RAPID TRANSIT LINE. Pennsylvania University. June 1971, Project No. Urt-8.

In February 1969, the Delaware River Port Authority initiated a new high-speed rail transit service connecting Lindenwold, New Jersey and Philadelphia. Patronage, which at the time of its opening was approximately 14,850 persons per day, 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. The results of the analysis of the data obtained on the flow of transit passengers through the stations 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. Entrance and exit gate meters were read at the scheduled departure time of each train from each station, permitting a more detailed analysis. 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. NTIS PB 203 780.

Pinkham RE. NOVEL FEATURES ON LINDENWOLD LINE. American Society of Civil Engineers Journal of Transportation Engineering. May 1972, v98, nTe2, Procedure Paper 8892, pp. 367-386, 12fig.

The new Lindenwold high-speed rapid transit line between Philadelphia, Pennsylvania and suburban Lindenwold, New Jersey covers 14.5 miles and owns 75 new, high-speed, automated cars. Parking facilities for over 8600 autos are provided at suburban stations. All stations are unmanned, but are protected by closed circuit television. Tickets, which vary in price from 30 cents to 60 cents, are sold by vendors and collected by electronic turnstiles. The right-of-way is fully grade-separated, either on conventional fill or on reinforced concrete elevated structures. Running rails are 132 pounds for ease of maintenance and current return capacity, and are fully welded, with joints only at signal block locations. All operations are directed, and substations controlled, from a central location. Management is aided by computer records of car, right-of-way, and fare collection expenses./Author/

THE LINDENWOLD LINE - A CASE STUDY OF THE NEWEST RAIL RAPID TRANSIT. American Automobile Association. 32 pp.

The Lindenwold Line, a rail transit line between Philadelphia and the suburban community of Lindenwold, New Jersey, is operated by the Port Authority Transit Corporation (PATCO), a subsidiary of the Delaware River Port Authority. The system has been in operation since January 1969 and includes many innovative features that are being planned and developed for new rapid rail transit systems in other metropolitan areas. Among these are scheduling at ten-minute intervals; large parking lots at suburban stations; trains designed for speed and comfort; a security system including television surveillance, telephones, and a police force; and the automated operation of fare collection, speed control routing, spacing, and stopping. Financing, patronage, and effects on traffic and on regional development are analyzed.

Johnston RB. PLANNING, IMPLEMENTATION, AND OPERATION OF THE PHILADELPHIA-LINDENWOLD LINE. Port Authority Transit Corporation, 1975.

Through careful planning and implementation, the Delaware River Port Authority has developed a highly successful mass transit system, the Philadelphia-Lindenwold Line. They have realized their goal of creating a rapid transit line which would win the patronage of potential passengers and be constructed and operated within the economic resources of the Authority. The one- to six-car trains are operated by a one-man train crew who is, in fact, part of the automated or computerized process. He notifies the computer as to the length of the train, opens and closes doors, determines the length in time of each stop, initiates acceleration, and can eliminate station stops. The computer determines train speed for each track section and right-of-way conditions, causes the train to decelerate at the optimum rate, and stops at the station with the center of the train and the center of the platform. The Lindenwold Line has demonstrated that motorists will leave their cars if superior transportation is provided; quality transit service can reduce air and noise pollution and conserve energy; traffic congestion can be reduced; technology is now available to create desirable rapid transit service; and that rail rapid transit can be planned, constructed, and efficiently managed to meet operating and maintenance costs out of the fare box.

Johnston RB (Port Authority Transit Corporation of Pennsylvania and New Jersey). RAPID TRANSIT CAN BE ECONOMICALLY SOUND. Passenger Transport. November 1975, v33, n48, pp. 1-8.

The Lindenwold-Philadelphia Rapid Transit Line has proved that attractive, modern rail rapid transit trains working in coordination with the private automobile can produce an efficient transportation system. Operational concepts which have contributed to the success of the transit include the following: the train is operated by one man regardless of the length; trains are designed to facilitate rapid changes in train-consist without intervening moves to a marshalling yard; successful automation; and an automatic fare collection system. The design of this transit system emphasized concepts of speed, reliability, and cleanliness. The factors which influence choice travel mode have been identified as (in descending order): speed, convenience, comfort, and cost. Features regarding the operating organization and operating results are briefly outlined. The transit service has shown that it can reduce air and noise pollution and conserve energy and materially reduce traffic congestion; existing technology is capable of providing the kind of rapid transit service which will induce automobile drivers to become transit riders.

GO TRANSIT. Ontario Department of Highways. Downsview/Canada/ April 1968, 36 pp.

A semi-technical description is provided of the government of Ontario transit rail commuter system, an experiment in the use of existing railway lines for rapid commuter operations, in order to reduce the rush-hour strain on the main highway arteries. Briefly, it describes: the formation of the transportation study, the search for solutions, the crystallization of the commuter concept, the equipment, stations, fares and

ticketing, scheduling, trackwork and signaling, and equipment servicing and maintenance.

Asher J. TORONTO DIGS, RIDES, AND DIGS AGAIN. Railway Age. September 1972, v173, n5, pp. 62-64, 7phot.

In the face of widespread declines elsewhere, the Toronto Transit Commission realized a 23 percent increase in revenue passengers over the decade 1962-1971. In the same period, the volume of rapid transit ridership (revenue plus transfer patrons) increased from 70 million to 162 million. Daily weekday ridership is well over half a million. A large part of this success is due to the imaginative, practical, and innovative management of the transit commission. This is particularly evident in the manner in which Toronto integrates various lines and services. Extensions are now under construction that will enhance systemwide integration. Although the system is still incomplete, several conclusions can be drawn from its years of operation. First, transit is an impetus to land development, and the taxes from development more than offset the cost of constructing the transit lines. Second, integration of routes and services has produced increased patronage during a period of virtually universal decline elsewhere. Finally, patronage can be stimulated without leaping at design innovations; the transit commission decision to keep PCC cars and trolley-buses has proved a sound one, and the system is operating with low maintenance and high safety in the absence of automated train control and air conditioning.

CHICAGO GETTING TWO MORE MEDIAN-STRIP TRANSIT LINES. Railway Age. December 1967, v163, n21, pp. 28, 30, and 45.

The Chicago Transit Authority believes its experience with the nine-year old Congress Street Line vindicates the concept of a median-strip transit line. The construction of two more lines is underway: the 9.5 mile extension in the median strip of the Dan Ryan Expressway and the 5.2 mile strip in the median strip of the Kennedy Expressway. Surface lines are cheaper to build than either elevated or underground lines. Additionally, a traffic corridor containing roads and transit is a highly efficient land use. Construction costs for adding transit in the middle of a highway increase by only a small increment, compared with the cost of building separate facilities for each mode. The median-strip idea as such is not new. Many cities are considering such systems.

THE SKOKIE SWIFT: A STUDY OF URBAN RAPID TRANSIT. Chicago Area Transportation Study. July 1968, 317, 031-VI, 110 pp.

The village of Skokie's Mass Transit Demonstration Project is summarized in its participation in the Chicago Area Transportation Study (CATS). CATS' participation in this two-year demonstration project consisted of collecting, processing, and analyzing data from a series of field studies. The Skokie Swift Demonstration Project extended Chicago Transit Authority (CTA) rail rapid transit service along the facilities of the North Shore Line, an electrified commuter railroad which abandoned service in 1963. The extension is five miles long, connecting a terminal in Chicago with a station in Skokie. Data were collected on the travel habits of

residents in the area when they are offered a new transportation alternative. It is concluded that overall transit ridership in the Skokie area increased markedly during the course of the demonstration project and this increase was absorbed almost wholly by Skokie Swift, the bus lines showing ridership figures which remained relatively constant or declined when Swift service began. Survey analysis indicated that diversion of loop-bound trips, where the Skokie Swift has its strongest competitive advantage, is made mainly from other rapid transit modes, along with suburban railroads and buses, with only a small number being diverted from automobile trips. Traffic on expressways linking the Skokie area with the city of Chicago was not noticeably reduced. The number of automobile trips diverted to the Skokie Swift is negligible.

Houser F. BOSTON CONVERTS COMMUTER LINES TO RAPID TRANSIT. Railway Age. October 1971, v171, n7, pp. 18-20.

Three weeks after its opening, Boston's newest transit line had a patronage that was 90 percent of that anticipated after a year's operation. The line is a six-mile route connecting Boston and Quincy over a right-of-way that belonged to a now defunct commuter railroad. Expansion farther down Boston's south shore is proposed. Three other major expansions to the north, south, and west over commuter rail right-of-way are planned for the years 1971-1975. Two reasons adduced for the success of Boston's rail rapid transit are (1) the new lines feed into existing downtown subways with multiple stations that mean many uninterrupted rides to final destination, and (2) the suburban stations provide both parking and feeder bus service. The new line's cars and operating characteristics are described.

- *Planned RRT Systems*

THE AIRPORT TRAINS ARE ON THE WAY. Railway Age. v163, n14, pp. 16-19.

Increasingly, rapid transit is talked of as a traffic-free means of reaching metropolitan airports, accessible today mainly over congested highways. The four-mile Cleveland transit system extension to Cleveland Hopkins Airport will open more than a year from now. Los Angeles, Philadelphia, New Orleans, and Denver are studying proposals to link rail terminals downtown with outlying airports. The Port of New York Authority is examining the potential of a road-rail vehicle capable of taking travelers from midtown Manhattan to Kennedy Airport. The Metropolitan Commuter Transportation Authority is considering 100-mph trains over the Long Island railroad to bring air travelers from Calverton to New York, 70 miles away. Boston's Revere Beach Transit Line has a stop near Logan Airport, with bus transfer service. In Europe, Brussels is linked to its airport by a commuter railway and London to one of its two airports the same way. For the other London airport, two schemes were advanced for bringing British railways and London transport trains from downtown./Author/

Millar J. Dean J. PRACTICAL CONSIDERATIONS OF RAPID TRANSIT -- A SUMMARY OF THE MANCHESTER STUDY. High Speed Ground Transportation Journal. September 1968, v2, n3, pp. 409-422.

A summary is presented of the work undertaken in connection with the rapid transit study in Manchester. The suitability was investigated of all proven systems of rapid transit that could be applied. The comparative feasibility study of transportation modes indicated that any rapid transit system for Manchester should be steel-on-steel duorail. A rail network evaluation is now being conducted. The values of an improved conurbation rail system, upgraded, if necessary, to rapid transit standards, will be assessed in relation to potential passenger demand and the costs which may be involved. It is emphasized that whatever system of rapid transit is adopted, the bus will always have a vital part to play as part of the general transport system, particularly at the local scale. Studies are being conducted to ensure that sufficient attention is paid to the requirement of bus operation in the planning of redevelopment areas. It is concluded that, in the field of public transport, the balancing of the three Buchanan variables of environment, accessibility, and investment is just as relevant as ever.

Atkinson I. "SUPERTRAM" NETWORK TO SPEED TYNESIDE TRAVELERS. Contract Journal. June 1975, v265, n4996, pp. 28-29.

The author discusses the "Supertram" network at Tyneside and what it will involve. The decision to adopt a rapid transit system is considered feasible due to the combination of traffic congestion and government aid. The track will require a bridge across the River Tyne, tunneling beneath the city center, and some realignment of part of the track already present from the river route toward the city. The costs of the phases of work are quoted. An overhead electrification system was selected because of greater safety. The two-track Tyne road bridge will soon go out to Tender; the bridge is a through truss design connecting directly with a tunnel at the cliff face. A viaduct is also used and a test track is under construction. The electronically operated "Supertram" was chosen for its quietness and freedom from fumes; the train will run directly to shopping areas, hospitals, and schools. Buses are expected to be used to transport people to the rapid systems and interchanges for public and private transport.

Ridley TM. TYNESIDE RAPID TRANSIT. Traffic Engineering and Control (United Kingdom). February 1973, v14, n10, pp. 486-489, 1fig, 10ref, 1phot.

Details are given of improvements planned for the whole system of public transport on Tyneside. These will consist in the provision of reserved track networks and new rolling stock and the integration of these networks with a reoriented bus system. The main feature will be the new metropolitan railway which will use substantial sections of the existing North Tyne Loop and South Shields commuter lines, linked by tunnels and bridges. Major interchanges with buses and essential parking facilities in these areas are also to be provided. Buses will be removed from densely trafficked streets in areas served directly by the metropolitan railway, enabling these streets to be converted to pedestrian precincts. Elsewhere, where congestion is less of a problem, more effective use will be made of buses. The rolling stock to be introduced will be modern, lightweight, electrically powered, and capable of high acceleration. The

government is to give a 75 percent grant toward the capital costs of the project. IRRD 205 897.

Myers ET. A NEW GEORGIA PEACH. Modern Railroads. February 1975, v30, n2, pp. 60-62.

Construction on Atlanta's new rapid rail transit system (MARTA) will begin this year. The task of acquiring right-of-way will receive much attention, since provision must be made for relocation of the people who will be displaced by the construction. Most of the planned route, though, will follow existing rights-of-way. A critical path system is being used for all construction and planning, with emphasis on critical areas so that revenue trains may begin running in 1978. Full completion is expected by 1980. The choice of car design was considered so important that it has taken a year to design the one that will be used. Rather than lend itself to experimentation, MARTA has decided to go with proven designs. It has learned from BART's mistakes, and has allowed more time for testing before becoming an operating reality. It intends to operate initially on a 15 cent fare, which will be increased until 1982, when fares will have to defray 50 percent of the costs.

PROPOSED REGIONAL RAPID RAIL TRANSIT PLAN AND PROGRAM. Washington Metropolitan Area Transportation Group (DC). December 1967, pp. 39 and 111.

A rapid rail transit system is proposed which will provide service for the District of Columbia and its outlying areas. The proposed system is 95.6 miles long with 82 stations and is composed of seven radial routes and a shuttle operation. Six of the routes originate in the heart of downtown Washington, while one begins at a junction in Rosslyn, Virginia. Four two-level stations provide transfer from one line to another. Transfer may also be made between the two Farragut Square stations and at the Rosslyn station. A substantial portion of the system must be in subway because of the unacceptability of overhead structures in certain areas of D.C. The system will carry an anticipated 158,000 peak-hour passengers (1990) and provide a high level of all-day service. Service will be provided over a 20-hour period from 5:00 A.M. to 1:00 A.M. The rail system will be geared to highway, street, and bus networks for accessibility. Parking facilities on major connecting roads are proposed for most of the outlying areas, thus giving access to the whole network of roads and highways outside the central destination areas, and making it convenient for park-and-ride use of rapid rail transit. The total estimated cost of construction and equipping the proposed facilities approaches $2.4 billion. The Washington Metropolitan Area Transit Authority estimates that revenue will be sufficient to cover all operating expenses and to repay approximately one-third of the costs of construction, equipment, and financing. The net project cost of $1.6 billion will have to be provided by the federal and participating local governments. The entire transit system can be put into operation by 1981.

- *Design and Operation*

AERIAL STRUCTURE AND RAIL SUPPORT METHODS REPORT NUMBER 11. Parsons-Brinckerhoff-Tudor-Bechtel. Project No. Cal-mtd-2.

A series of tests was run for BARTD to evaluate the ability of rail fasteners to maintain electrical isolation, reduce noise levels, and provide safety and economy and to determine their suitability for use on advanced design concrete aerial structures. The evaluation of several types of concrete ties and the results of tests on a new concept in the installation of rail fasteners and associated hardware on concrete aerial structures are included. Investigation showed that a new concept of track support was required for aerial structures and subways; further, it was realized that the fastener chosen for use on the aerial structures can also be used on the underground portions of the rapid transit system. Subsequent studies, therefore, are geared to the choice of a fastener suitable for use on aerial structures. Such rail fasteners must be simple enough for one man to assemble with hand-carried tools. The fastener must remain stable under the application of a 15,000-pound wheel load and must be capable of holding a longitudinal force of approximately 2000 pounds of 3,000,000 cycles of loading in a test machine. Other criteria for fasteners of rail and aerial structures are listed. The "second pour" technique, which requires further development, is to be used in installing track fasteners on concrete surfaces in order to guarantee that the anchor bolts will not come in direct contact with reinforcing steel. Indications from test results indicate that concrete ties are safe and economical and perform well under the type of transit loadings expected in the BARTD system. NTIS PB 177 496.

Wilson GP. AERIAL STRUCTURE NOISE AND VIBRATION MEASUREMENTS. Wilson, Ihrig and Associates. October 1966, Project No. Cal-mtd-2.

The results of sound and vibration level measurements taken at the aerial structure section of the test track of the San Francisco Bay Area Rapid Transit System are presented. The primary objective of these tests was to compare the performance of prototype rail fasteners with regard to wayside noise level and mechanical vibration isolation. In addition, the effectiveness of a sound barrier (acoustic parapet) as a wayside noise reducing device was to be evaluated. The results indicate that the highest sound levels were observed, at the wayside and in the car, with the fasteners which gave the greatest rail vibration level. The sound barrier, which could reduce noise from the car and rail but not from the structure, gave a substantial noise reduction. These results indicate that the aerial structure is not the principal noise source, except possibly for frequencies below 250 cps. HRIS 52 081755.

Madigan RJ. URBAN RAIL SUPPORTING TECHNOLOGY PROGRAM - FISCAL YEAR 1973 YEAR END SUMMARY. Transportation Systems Center. Final Report. October 1974, DOT-TSC-UMTA-74-15, UMTA-MA-06-0025-74-9, 64 pp.

The Urban Rail Supporting Technology Program, being conducted for the Department of Transportation Urban Mass Transportation Administration (UMTA) is described for the 1973 fiscal year. Major areas covered include program management, technical support and application engineering, facilities development, test and evaluation, and technology development. Specific technical discussion covers track geometry measurement, UMTA facilities development at the High Speed Ground Test Center at Pueblo, Colorado, rail car test and evaluation, especially of the State-of-the-

Art Car (SOAC) and of Boston's MBTA Green Line, instrumentation for data acquisition and processing, noise abatement methodology, and tunneling and crashworthiness studies.

Leonard GB. RAIL TRANSIT CAR COSTS: A REVIEW, ANALYSIS, AND PROJECTIONS. Southern California Association of Governments. February 1975, 158 pp.

Operational characteristics of present rail transit systems are discussed. Expenditures for rail cars and a forecast of their cost between 1975 and 1980, based on a complete documentation of all car orders between 1962 and the present, are presented. Major findings of this study are the possible cost projections for the various rail car types in use throughout the United States and Canada and the cost of equipment suitable for the Los Angeles area. Using the Erie Lackawanna's recent locomotive-hauled push-pull equipment as a reasonable example of the kind of rail car which might be employed for commuter purposes, the anticipated cost would vary in the range of $295,000 to $320,000; for light rail transit, the cost would roughly approximately $390,000; and a projected cost of $450,000 to $475,000 would generally apply to rapid transit-type equipment.

Dunton WH. Norton PR. GUIDELINE SPECIFICATION FOR URBAN RAIL CARS. Boeing Vertol Company. Urban Mass Transportation Administration, DOT. Final Report. Report No. UMTA-IT-06-0027-73-1, Contract No. DOT-UT-10010, 187 pp.

This document is the guideline specification to be used as the standard form for the preparation of detail procurement specifications for the design, construction, and test of self-propelled urban rail cars. Guidelines are provided for both commuter and rapid transit rail cars. This specification encourages the use of modern technology and innovation by establishing measurable performance objectives rather than specifying existing equipment or equivalent. The specification covers all subsystems of the vehicle applicable to this type of equipment as a class and is not unique to one design. NTIS PB 220 678.

GUIDELINES AND PRINCIPLES FOR DESIGN OF RAPID TRANSIT FACILITIES. Institute for Rapid Transit. May 1973, 84 pp.

These recommendations reflect accepted practice for design and construction of new rapid transit systems. The scope is limited to structures and fixed equipment applicable to structures, and emphasis is placed upon the environmental features which directly affect the safety and convenience of the transit patron. Topics covered include patron circulation and exits, security, fire protection, lighting, subway ventilation, acoustics, graphics, public telephones and communications, concessions, sanitary services, facilities for the physically handicapped, station finish materials, and waterproofing. A summary of applicable standards presently in use by rapid transit agencies is presented in the appendix./Author/

Mouritzen G. CURVED TRACK RAPID TRANSIT SYSTEMS. High Speed Ground Transportation Journal. June 1971, v5, n2, pp. 189-198.

New rapid mass transportation systems are discussed. All have a common main feature of being automatically self-banking at any speed and radius of curvature. The curved track systems would provide practical, economical, and efficient rapid transit systems which could easily be integrated into existing transportation systems and facilities. They can be built using existing technology and hardware and can provide faster service than combinations of existing transportation modes now used between and within many cities.

RESEARCH BIBLIOGRAPHY: VENTILATION AND ENVIRONMENTAL CONTROL IN SUBWAY RAPID TRANSIT SYSTEMS -- PHASE I. Kaiser Engineers. August 1971, Project No. Dc-mtd-7.

This is a research bibliography of major references in four areas: (1) passenger comfort (human tolerances and preferences to various conditions in the physical environment), (2) subway environment,(3) high-speed ground transportation, and (4) aerodynamic properties of vehicles in tubes. Bibliographic source material was obtained from various university library collections, indexes of both public and private engineering research, and specialized literature searches. The documents span a period of 30 years and reflect state-of-the-art in all subjects. References are listed alphabetically by author within each topical category, and complete bibliographic information is provided. The index also indicates which reports will be available from the institute for rapid transit upon completion of the environmental study program. NTIS PB 205 996.

Haney DG. BENEFIT/COST ANALYSIS OF THE FIVE-CORRIDOR RAPID TRANSIT SYSTEM FOR LOS ANGELES. Stanford Research Institute (Menlo Park). May 1968, 191 pp.

The proposed Los Angeles rapid transit system represents a major investment by the residents of the Southern California Rapid Transit District that would drastically change the current trend of overwhelming dependence of the private automobile for local travel. On completion of a benefit/cost analysis, it has been concluded that the proposed rapid transit development represents a sound public investment relative to accepted standards of expected public benefits and costs. The total benefits to district residents expected to be generated by the proposed rapid transit project are estimated to be valued at $253 million annually. Traveler benefits have been estimated at about $85 million per year (in 1968 dollars); community benefits are $109 million per year, plus an annual adjustment of $59 million for inflationary effects. In addition, there should be a decrease of 32 fatalities and 1900 injuries per year; benefits to bus riders in service improvements or fare reductions valued at $14.9 million; and benefits to airport service patrons of $3.1 million annually./Author/

Walker WJ. Howell JK. TRANSIT EXPRESSWAY -- A NEW MASS TRANSIT SYSTEM. Westinghouse Engineer. July 1965, v25, n4, pp. 98-103.

The transit expressway system has been designed to provide an unusually high level of service at any hour of the day or night, with capital and operating costs substantially below those of conventional systems

supplying frequent 24-hour service. The chief factors in reducing costs are the use of lightweight vehicles, consequent lightweight roadway structures, and the ability to dispatch the required number of vehicles or trains to satisfy fluctuating passenger loads without a fluctuating labor force. A transit expressway system would be integrated with other modes of transportation. For a very large city, for example, it might be an outlying feeder for the central rail rapid-transit system; for smaller urban areas, it would be the central system. In the latter application, feeder buses would take passengers to and from the outer parts of the loop, or automobile parking areas would be provided at the stations. The entire complex would be built for flexibility to accommodate changing traffic patterns and increased traffic volume as the urban area grows. For example, trains could be made longer, up to the practical limit, and stations would be so built that they could be lengthened to accommodate the longer trains. Intervals between trains could be shortened to as little as 1-1/2 minutes. Feeder buses could be routes as required to properly distribute passenger loads at the various stations./Author/

Thomas K. Dyer, Inc. RAIL TRANSIT SYSTEM COST STUDY. Prepared for Urban Mass Transportation Administration. March 1977, UMTA-MA-06-0025-77-12 NTIS PB 266-918, 114 pp.

This report assesses cost of constructing, operating and maintaining three kinds of urban rail systems: light rail, rapid rail, and commuter rail. Cost data from both North American and European transit authorities were collected and analyzed. These data, together with recent experience in several transit construction projects, served as basis for cost projections. Factors influencing appreciable cost variations in construction and operations are reviewed.

AUTOMATED GUIDEWAY TRANSIT

- *Concept Definitions*

Fichter D. SMALL CAR AUTOMATIC TRANSIT. Highway Research Record, Highway Research Board. 68, n251, pp. 47-62.

A small car automatic transit (SCAT) is a system of driverless, individualized transport. It is a merging of taxi-like aspects with features of the minirail transit installations at the Expo 67 in Montreal. SCAT is a system of small cars capable of unattended operation individually over an urban network of exclusive trafficways. The cars run only on tracks, vehicles are driven on roads, and dual-mode conveyances are adaptable to either. Small car automatic transit is examined primarily in the physical context of the middle-sized metropolis. The SCAT facilities would form a network coinciding generally with the more traveled thoroughfares: most downtown streets, many of the arterials in the rest of the city, and suburban highways. The new mode should be beneficial both to tripmakers and to urban environment by reducing dependence on automobiles and by abating the environmental pollution and hazards due to vehicular traffic. Door-to-door transport might be offered by modifying the SCAT system to accommodate dual-mode conveyances which would run driverless on its facilities, but could also be driven on roads. Should small car automatic transit eventually become feasible, it would be a factor in metropolitan planning. The central business district would be affected by a metropolitan SCAT installation. It would improve the efficiency by greatly facilitating local circulation.

Anderson JE. Kieffer JA. COMPARISONS BETWEEN FIXED-GUIDEWAY TRANSIT CONCEPTS FOR MEDIUM-DENSITY METROPOLITAN AREAS. Urban Technology Conference. May 1971, n71-518, 10 pp.

A critical examination is made of the growing deficiencies of the auto system as a major mode of transportation in urban areas. Based on this discussion and consideration of the fundamental needs for urban transportation, a set of criteria for effective transit is presented and discussed. By comparison with the criteria, contemporary transit concepts are shown to be deficient in fundamental ways. The argument then leads to a new concept of urban transit in which small vehicles run on fixed guideways under automatic control. An essential feature for success of this new system is that the stations are off the main line. It is shown that the new system, called personalized rapid transit (PRT), can meet criteria for effective transit./Author/

Grimble LG. DESCRIPTION OF A GUIDED AUTOMATED INDIVIDUAL TRANSPORTATION SYSTEM. Canadian Council of Urban and Regional Research (Ottawa). February 1968, 115 pp., 13fig, 362ref.

A suitable transit system was sought for middle-sized Canadian cities. The method of the study was an exhaustive review and evaluation of the massive literature now available on the subject of urban transportation and a study of current research projects. This literature describes systems in actual operation, in various stages of experimentation, or

still purely hypothetical. A definition of the ideal system was developed against which to measure the various systems being studied and evaluated. New ways in which transit services can be improved and diversified have been illustrated.

Langdom MG. THE CABTRACK URBAN TRANSPORT SYSTEM. Traffic Engineering and Control (United Kingdom). April 1971, v12, n12, pp. 634-638.

One of the fundamentally new ideas for moving people in towns is the use of automatically controlled small vehicles moving on segregated guideways. The cabtrack system being studied at the Royal Aircraft Establishment is an example; it consists of four-seater cabs running on a network of interconnected tracks, with access at "cabstops" at frequent intervals. Cabtrack should provide sufficient capacity to match most of the travel requirements of large towns, and should be possible to install without causing a major disruption of the existing environment.

CABTRACK. Architects Journal (United Kingdom). May 1971, v153, n20, pp. 1112-1123.

The rapid transit system Cabtrack, which could supplement existing transportation modes, consists of small, automatic, electrically powered cabs which travel on an elevated track directly from origin to destination without intermediate stops. A computer can redirect the cabs to the same destination via another link in the network should any one part of the system become overloaded. All movements, including ticketing, the deployment of empty cabs to areas of high demand, clearance of breakdowns, and diversion, are controlled by a central computer. Three sites in central London having particular urban characteristics were selected for the study of environmental constraints and for testing the acceptability of Cabtrack.

Blake LR. A PUBLIC-TRANSPORT SYSTEM USING FOUR-PASSENGER SELF-ROUTING CARS. Institute of Mechanical Engineers Proceedings (London, United Kingdom). October 1966, n48, 13 pp.

The proposed system is an automatic-taxi, public-transport service for towns and cities, capable of 10,000 passengers per hour per track and aimed to be competitive with the private car. Mini-sized cars are used which carry up to four adult passengers, using induction-motor drives powered from an overhead rail. The cars are driverless and route themselves at 35 mph to their destinations with no stops at intermediate stations, though they are slowed down when changing to another line. The cars move along a lightweight, totally enclosed track of less than seven feet diameter, which can be supported above existing roadways or buildings. The total capital cost is of the order of 400,000 pounds per single-track mile and the total operational cost $1 to $2 per passenger-mile. A complete system for a town of 400,000 inhabitants, involving 100 single-track miles, would cost from 30 million to 40 million pounds.

Wheatcroft ELE. Woodhouse LC. MONORAILS. Institute of Mechanical Engineers Proceedings (London, United Kingdom). October 1966, n2, 14 pp.

The authors define the monorail as a transport system which does not depend on width of track (e.g., rail gauge) to keep the vehicles upright. Two basic types have been developed, namely the supported type where the car rides on a narrow beam and is kept upright by wheels running on the side of the beam and the suspended type where the beam is hollow with a continuous slot on the underside allowing the cars to be suspended from a driving trolley running inside the beam. There are only two monorails at present operating full-scale passenger service: one of the suspended type, 60 years old, in Wuppertal, Germany and one of the supported type, two years old, in Tokyo. The paper includes engineering details of the latter, and briefly describes a modern version of the suspended type. The authors suggest that the likely future for monorails is in urban-suburban passenger transport where right-of-way problems make surface lines impracticable (and motor transport is no solution). Proposals for such monorails, however, still have to compete with conventional rail which can, of course, also be constructed overhead and has advantages wherever the system is to be at grade or in tunnel.

- *Technology Assessment*

TECHNICAL PAPERS. 1975 INTERNATIONAL CONFERENCE ON PERSONAL RAPID TRANSIT. VOLUMES I AND II. Minnesota University (Minneapolis), Colorado University (Denver). September 1975, 938 pp.

The following papers are contained in these two volumes: "Role of New Technology in Urban Transportation: An Historical Perspective," A. Kornhauser and L.B. Wilson: "Research and Development in the Field of Urban Transportation in the Federal Republic of Germany from the Viewpoint of the Government," H. Zemlin; "Public Transportation Service Quality -- Some Program Alternatives," L.A. Goldmuntz; "The Morgantown PRT Alternatives Analysis Study: An Application of an Evaluation Technique," D.R. Miller; "Practical Solutions for the Financing and Construction of PRT Systems," R. McDonald; "Guideway Transit for Southern California: A Policy Analysis," J.R. Lawson, et al; "The Development of a Model for Analysis of the Cost Effectiveness of Alternative Transit Systems," J.E. Anderson; "A Scenario -- Specific Methodology for the Evaluation of Personal Rapid Transit Alternatives and Network Designs," S.C. Iverson; "A Rationale for Automated Personal and Group Transit Development," R.K. Lay; "Performance Limits of Automated Steering Controllers," S.E. Shladover; "An Analysis of Merge Control for the Automated Transportation System," M. Sakasita; "Analysis and Simulation of Automated Vehicle Stations," R.E. Johnson, et al; "Automated Guideway Ground Transportation Network Simulation," C. Toye; "Normal and Emergency Control of Automated Vehicles at Short Headways, In Particular the Development, Testing, and Dynamic Simulation of the Cabin Taxi System," R. Hesse; "The Influence of the Size and Number of Vehicles on the Performance and Service Quality of Group Rapid Transit Systems," G. Bahm; "An Evaluation of Group Rapid Transit," B.M. Ford, et al; "Development and Evaluation of Service Policies for Medium Headway Automated Rapid Transit Systems," K. Thangavelu; "Operation Issues in Small Vehicle Automated Guideway Systems," P.A. Anderson and J.H. Pejsa; "Vehicle Management on Large PRT Networks," J.H. Irving, et al; "Systems Management Analysis of Large AGT Networks," M.S. Ross and A.D. Melgaard; "PRT in the Land-Use Environment: The Implied Changes," A. Kornhauser

and C.E. Phillip; "Using New Transit Technology to Shape Suburban Growth," J.M. Lutin; "The Psychological Impact of Personal Rapid Transit," P.B. Everett; "The Place of 'Autotram' in a Modern British Transportation Planning Mechanism," C.J. Longley; "Application of Computer-Drawn Motion Pictures for Demonstration of Urban Transportation Concepts," E.S. Joline and J.C. Hayward; "Visual and Environmental Effects of Minitram Guideways," W. Russell; "The Design of Elevated Guideways and Stations for Minitram in Sheffield," M. Bayer and W. Grimwade; "Operating the Ford Act System in a Snow and Ice Environment," B.K. Barrowcliff; "Cost and Performance Relationships for Rubber Tired Automated System Design," J. Putukian; "The Cost Aspects of Elevated Guideway Design," E. Prestegaard; "The History of Minitram in Sheffield," W.T. Bordass; "Design and Application of the Siemens/Duwag-H-Bahm," F. Frederich; "Cabinentaxi: Technical Level, Market Situation, and Targets," K. Becker; "CVS (Computer-Controlled Vehicle Systems)," T. Ishi, et al; "Crashworthiness and Crash Survivability for Personal Rapid Transit Vehicles," W.L. Garrard, et al; "Review of Automobile Crashworthiness Experiments with Respect to PRT Systems," P.M. Miller and N.E. Shoemaker; "Safety Estimates for Urban Transit Systems," D. Morag and T.J. McGean; "Safety and Reliability of Automated Urban Transportation Systems," K. Heinrich; "Some Reliability, Dependability, and Safety Considerations for High-Capacity PRT Systems," C.L. Olson, et al; "Service Dependability Evaluation and Design Considerations for Automated Transit Systems," A.F. Ems, et al; and "Network Dynamics in a Large Personal Rapid Transit System Failure," R.M. Wade.

AUTOMATED GUIDEWAY TRANSIT. United States Congress. June 1975, 399 pp.

This assessment of Personal Rapid Transit and other forms of Automated Guideway Transportation has been prepared in response to a request from the United States Senate Committee on Appropriations. Its objectives: to provide the committee with information on the current status and social and economic aspects of Automated Guideway Transit development; to assess the key problems associated with AGT as perceived by potential riders, the communities, and the transit industry; to identify major policy issues and automated guideway transit program alternatives and to explore their implications. It is concluded that, to date, the Federal AGT R&D program has not produced the direct results which could be reasonably expected from an expenditure of $95 million. This report was prepared at the request of the Senate Committee on Appropriations, Transportation Subcommittee.

Cole LM. FEDERAL RESEARCH AND DEMONSTRATIONS IN NEW TRANSIT TECHNOLOGY: THE MORGANTOWN, WEST VIRGINIA PROJECT. Library of Congress. May 1975, 53 pp.

The report examines the technical and political context in which the automated guideway transit (AGT) research and demonstration project, conducted by the Urban Mass Transportation Administration at Morgantown, West Virginia, was undertaken, and assess its accomplishments against both stated and apparent objectives. Conclusions are that, while the project has failed in reaching any of its objectives, the federal expenditures and efforts may prove not to be a total waste. A fundamental conclusion that can be drawn from the project experience is that the cost and

complexity of high technology AGT systems applied to urban use is much more than originally estimated, even with perfect project management and cost effectiveness decisions. If presently high unit costs of advanced technology systems are to be reduced, the problems of market aggregation, production, and governmental implementation must be much more rigorously addressed.

Yu JC (Utah University). Argo PS (E&A Engineers and Planners). A FEASIBILITY STUDY OF MORGANTOWN PRT SYSTEM FOR THE CENTER CITY OF RICHMOND, VIRGINIA. High Speed Ground Transportation Journal. March 1975, v9, n1, pp. 473-481, 3tab, 16ref.

The feasibility of implementing a PRT movement, similar to the one presently uder construction in Morgantown, West Virginia, is studied for the center city of Richmond, Virginia. A travel demand model is first developed for forecasting travel patterns on the basis of trip characteristics within the study area. A benefit-cost analysis is then performed with the benefits derived from the relief of travel congestion and the PRT system costs obtained from currently available data sources. Results of the study indicate that it would be economically feasible to install the Morgantown system in the Richmond CBD under a set of assumed conditions.

AIRPORT PEOPLE MOVER: "MOST SOPHISTICATED" SYSTEM BEING TESTED IN SEATTLE. Passenger Transport. American Transit Association. May 1972, v35, n19, p. 8.

Westinghouse Electric Corporation has begun testing the vehicles and automatic train controls for the new passenger transit system being installed at the Seattle-Tacoma International Airport. Nine 106-passenger vehicles will carry air travelers to and from their boarding gates. The lightweight electric vehicles have rubber tires and are propelled by 100-horsepower motors, providing smooth, quiet, fume-free operation. The entire system is scheduled to go into operation later this year. Automatic operation will be supervised by a central control computer, which will control station dwell times and make sure that the trains are properly spaced on the system at all times for passenger convenience. Tests also are being conducted on transfer tables that will be used to move the vehicles off or on the guideways for maintenance or operation. Start-up tests are also underway on the station doors and communications and power systems.

Li S. THE LATEST SWISS AUTOMATIC GUIDEWAY TAXI SYSTEM. New Concepts in Urban Transportation. October 1972, v2, n7, pp. 228-232.

Switzerland, which has traditionally been a pioneer in special public transport systems, 12 years ago was the source of a proposal for guideway taxis running on an asphalt surface and electrically propelling two- and four-seat cabins. The Lausanne Expo of 1964 included an operational personal rapid transit (PRT) system; other systems have been developed since then. One of these, called "elan," is a product of two development engineers at the Swiss industrial society. System criteria were a riding comfort on the order of that of the private auto, high reliability, state-

of-the-art safety measures, and a capacity of 20,000 passengers per hour at 0.7 second headways. The system is a guideway taxi for public transport with a PRT capability. All subsystems and operational characteristics of the system are described, and certain comparisons with other transport modes are made.

Albach WC. Metcalf JM. AIRTRANS -- A NEW GENERATION OF TRANSPORTATION. American Society of Mechanical Engineers. Intersociety Conference on Transportation (Denver). September 1973, 13 pp.

AIRTRANS, the people and cargo moving system for the new Dallas-Fort Worth Airport, is the largest PRT (personal rapid transit) system in operation or under construction in the world. Consisting of 68 vehicles operating on 67,700 feet of guideway with 71 switches, 28 passenger stations, and 25 cargo stations, this automatic system truly represents a new generation of transportation. This paper discusses the design of the basic AIRTRANS vehicle and includes the system constraints and requirements, a general system description, a vehicle description, vehicle and operating interfaces, utility vehicle (cargo) application, and conclusions.

AIRTRANS AUTOMATIC TRANSPORTATION SYSTEM DESIGN SUMMARY. LTV Aerospace Corporation (Dallas). 9 pp.

A description of AIRTRANS at the Dallas-Fort Worth Airport includes routes, guideway system, vehicles, entire control system, and types of stations. The description of the system is for the general audience.

- *Role of AGT*

Cannon RH, Jr. TRANSPORTATION, AUTOMATION, AND SOCIETAL STRUCTURE. Proceedings of the Institute of Electrical and Electronics Engineers. May 1973, v61, n5, pp. 518-525.

Extensive use of automation in transportation systems will bring from existing rights-of-way higher capacity, greater safety, and far better service at lower costs through system and total trip management. Examples of prediction at five system levels illustrate the way that automation will be upgrading future transportation and challenging us to predict its consequences for our economy and for the structure of our communities. It is hoped that new Department of Transportation programs in technology and planning tool sharing and in university support will be helpful in the decision-making process. This is the lead article in a special issue on ground transportation for the 1980's.

Bordass W (Matthew, Johnson, Marshall and Partners). FOCUS ON GUIDED URBAN TRANSPORT. MINITRAM IN SHEFFIELD: A CONSULTANT'S VIEW. Traffic Engineering and Control. April 1975, v16, n4, pp. 172-174, 4fig, 4phot.

An outline is given of the minitram demonstration project proposed for Sheffield by Robert Matthew, Johnson, Marshall and Partners, in consultation with TRRL. The aim is to test minitram in public use and, in particular, to answer questions related to public acceptance, vandalism, and reliability. After giving consideration to hardware, minitram vehicle

dimensions, guideways, and stations, the author indicates that: (1) the elimination of drivers by automation necessitates the use of new skills in the control room and thus reduces the expected savings in costs; (2) the location of guideways close to buildings brings about problems of visual intrusion; and (3) if minitram is to be comparable with buses, stations have to be closely spaced and are hence fairly expensive to build. It is concluded that minitram might be suitable for some cities at present considering the introduction of rail rapid transit systems, but that only a public demonstration will reveal its true potential.

Olafson G. A METHODOLOGY FOR THE LOCATION OF PERSONAL RAPID TRANSIT. Minnesota University. Program of Urban Transportation Final Report. August 1973, Contract UMTA-URT-3, 101 pp.

The study represents an effort to develop a methodology to assist planners and engineers in the design of first-cut personal rapid transit networks. Personal rapid transit systems consist of small, automatically controlled vehicles utilizing their own guideway and off-line stations. Most previous network generation models have not demonstrated their usefulness for such systems. An index is defined for the study, called the opportunity index, by which the network is evaluated and compared to the present auto-street system. It consists of a modification of the standard accessibility index. The methodology is first developed in a general way and the rationale for the opportunity index is presented. The method is then demonstrated by designing a PRT network for a section of Minneapolis. /Author/ NTIS PB 224 413/5.

Reid M. HORIZONTAL ELEVATORS SERVE AIRPORT PATRONS LIKE TAXICABS. Product Engineering. March 1970, v41, n5, pp. 65-66.

The monocab automated transit system has been designed to move a multiplicity of small vehicles according to individual passenger demand. Six-passenger electrically powered cars are suspended from a guideway that can circle and criss-cross areas of maximum activity, such as airports, university campuses, shopping centers, and downtown business blocks. The monocab vehicles are powered through electric distribution lines built into the overhead guideway. Each cab is an independent unit, with propulsion by two 20-horsepower dc motors.

Loder JL (Loder and Bayly). PERSONAL AUTOMATED TRANSPORTATION: A PAT SOLUTION FOR AUSTRALIAN CITIES. Transportation Planning and Technology. 74, n2, pp. 221-262.

Despite the rapid rise in material standard of living, cities have become less pleasant places in which to live. In order to reverse this trend, transportation systems need early attention. An examination of the parameters which set limits to the location and design of an automated transportation system, within the constraints of available technology, leads to the specification for a system designed to serve a major Australian city. A complete description is given of all parts of the system including: layout and station location; the guidance and type of motor to be used; the three types of vehicle to be carried by the system; and line speed and average waiting time. The total cost of the system is calculated

in a simple way. The stages in which the scheme would be implemented are discussed. These would involve restructuring the local car industry and changing the form of the taxes levied upon the ownership and use of cars. Appendices describe the technical options available, the method of calculating the cost of the system, and developments in rapid transit systems in other countries.

- *Control Technology*

CONFERENCE ON CONTROL ASPECTS OF NEW FORMS OF GUIDED LAND TRANSPORT. Institute of Electrical Engineers Conference Paper (London). August 1974, n117.

The following papers were presented at the conference: "Simulation of Train Following Behavior in HSGT Systems," F.T. Barwell and D.J. Leech; "Railway Cybernetics," E.E. Gelbstein and W.T. Parkman; "Practical Headway Limitations for Personalized Automated Transit Systems," E.S. Hinman and G.L. Pitts; "Longitudinal Track to Vehicle Communications," B.W. Hutchings and D.J. Cree; "The Solution of Merging and Control Problems of a Deterministic Auto-Taxi System," T.O. Jeffries and F. Cox; "The Effects of Mandatory Speed Restrictions upon an Automated Vehicle Following System," B. Mellitt and H.J. Calderbank; "Control Strategies of Non-scheduled Traffic in a Timetabled System," B. Mellitt and D.P. Ward; and "Safety Requirements for the Longitudinal Control of Tracked Automatic Vehicles after the Demerging of Contact Trains," F.C. Perrott.

Hajou LP. et al. DESIGN AND CONTROL CONSIDERATIONS FOR AUTOMATED GROUND TRANSPORTATION SYSTEMS. Proceedings of the Institute of Electrical and Electronics Engineers. April 1968, v56, pp. 493-513.

Operation of proposed future metropolitan ground transportation systems, using automated single-lane guideway networks with closely spaced vehicles, is analyzed. The important independent and dependent system variables and the associated constraints are identified, and basic relationships between these variables are discussed. In an attempt to find a useful measure of performance, two highly significant performance criteria are formulated: The weighted average travel time and the relative safety of travel. Both are strongly related to the quality of service provided by transportation systems, and can be applied as useful tools for synthesizing future systems and evaluating alternative approaches. The main control functions that are instrumental in achieving the desired high level of performance in these future systems are identified and briefly discussed. Instead of proposing specific solutions, the discussion attempts to give a good understanding of the control problems of systems employing a large number of automatically controlled relatively small vehicles, particularly those problems arising from short headways and merging vehicle flows. The headway and main line speed control are identified as the control functions most critical to system performance (travel time, capacity, and safety). The discussion of the control philosophies is intended as basic background information for the systems engineer unfamiliar with the details. In relating guideway capacity to safety, the ratio of minimum headway to the nominal stopping distance is identified as an important system parameter. The guideway capacity, the

relative safety, and the complexity of the control system are expressed in terms of this factor. The main limitations of the approach are the complexity of modern transportation systems and the inherent difficulties in assessing their cost-benefit relationships. Thus, while this paper identifies the nature of many of the problems, further extensive research will be required to extend the method presented here to full-scale systems.

Boyd RK. Lukas MP. HOW TO RUN AN AUTOMATED TRANSPORTATION SYSTEM. Man and Cybernetics. Institute of Electrical and Electronics Engineers. July 1972, vSmc-2, n3, pp. 331-341.

The synchronous longitudinal guidance (SLG) approach to allocating guideway space and controlling traffic in a ground transportation network is described in this paper. The transportation system considered is one in which completely automated vehicles follow deterministic position-time profiles during their travel through the network. The key feature in the SLG approach is a dynamic scheduling algorithm which allocates guideway space to vehicles in such a way that the capacity of critical points (or bottlenecks) in the network is not exceeded. This guarantees that traffic flows smoothly through the entire network and that queues are confined to the entrances. Two scheduling algorithms are identified. The basic slot allocation algorithm used in processing vehicle trip requests is outlined first. Then, the more general cycle allocation algorithm, which is suitable for control of large networks, is described. The results of a computer simulation of a network run, using the latter algorithm, are summarized, and the required auxiliary SLG functions of entrance and exit control, merge control, and safety assurance are discussed briefly.

TEST TRACK WILL DEMONSTRATE TRANSIT CONTROLS. Engineering News-Record. September 1971, v187, n10, p. 13.

A 15-acre test tract is designed to develop and demonstrate electronic control systems developed for the United States manned space program which have been adapted to any type of driverless public transit vehicles, rail guided or unguided. The test track includes a computer control center and a maze of one-lane asphalt roads that branch and cross each other to permit simulation of all traffic situations. High-frequency signals from a cable embedded 1.5 inches under the middle of the 5500-foot roadway will guide the vehicles around the track. A pair of wires embedded in the track, one foot on either side of the steering cable, enables the computer center to issue a variety of commands. The track is laid out to study such problems as pulling a vehicle off the main track into a station, handling crossings at intersections, and merging vehicles.

Kornhauser AL. McEvaddy P. QUANTITATIVE ANALYSIS OF SYNCHRONOUS VERSUS QUASI-SYNCHRONOUS NETWORK OPERATIONS OF AUTOMATED TRANSIT SYSTEMS. Transportation Research. August 1975, v9, n4, pp. 241-248.

This paper investigates the performance of the synchronous and quasi-synchronous network control policies proposed for modern automated transit systems. Performance is analyzed from the user point of view in terms of the expected travel time delay associated with each policy.

Using an idealization of the network layout and uniform demand for service, analytic expressions for the expected delay are derived for each policy in terms of fundamental parameters (line spacing, trip rate, trip length distribution, maneuver region). Comparisons of the performance of each policy are presented in parametric form./Author/

Morag D. OPERATING POLICIES FOR PERSONAL RAPID TRANSIT. Urban Mass Transportation Administration (RDD-8). May 1974, UMTA-RDD-8-74-2, 100 pp.

Personalized Rapid Transit (PRT) systems development is concerned with the more complex new generation of PRT systems that will utilize small automated vehicles closely spaced on an exclusive right-of-way to achieve a higher lane capacity and non-stop service, along with reduction of traffic congestion and pollution. The author perceives a need to carefully define and study operating policies relating to vehicle separation and velocity as the capacity of the system increases. This report describes and evaluates operating policies for PRT systems and illustrates their implementation in a PRT vehicle autopilot. The vehicle frequency of passage and other considerations that contribute to the selection of such frequencies are the major topics of the report. Also studied are the various effects on system parameters and performance that follow the selection of an operating policy. The report examines three potential operating policies for PRT systems and defines the necessary limitations on headways resulting from design parameters and the effects of maneuvers. The operating policies considered are constant separation, constant K factor, and constant headway operation. A longitudinal control system was devised for the purpose of testing implementation of each operating policy. This test was accomplished by a digital computer simulation of a string of PRT vehicles controlled by the longitudinal control system models and operating according to the various policies. NTIS PB 239-825/AS.

York HL. Garrard WL. Kornhauser AL. VEHICLE SCHEDULING AND CONTROL IN PERSONAL RAPID TRANSIT. Minnesota University. September 1973, Final Report No. UMTA-MN-11-0003-73-3, 135 pp.

This report consists of three separate studies which cover the various aspects of the scheduling and control of personal rapid transit vehicles. The first study, "The Simulation of a PRT System Operating Under Quasi-Synchronous Control," discusses the operational strategy of a PRT system operating under such control and demonstrates the feasibility and limitations of this strategy in a very high-demand situation using a computer simulation. The second paper, "Design of Optimal Feedback Systems for Longitudinal Control of Automated Transit Vehicles," applies optimization theory to the design of feedback control systems for high-capacity automated transit systems. Resulting controllers minimize headway and velocity errors without causing passenger discomfort. Significant dynamic response is achieved during normal mainline operation, merging and demerging, maneuvering, and emergency stopping. Illustrative design charts are presented and the effects of the propulsion system dynamics are discussed. The third paper, "Use of State Observers in the Optimal Feedback Control of Automated Transit Vehicles," discusses the theory of optimal control and the theory of observers as applied to the design of

feedback systems for longitudinal control of vehicles in automated, high-capacity transit systems. The only measurements required by the resulting controllers are those of position and velocity errors. The authors find that significant dynamic response is achieved for main line operation, for merging and demerging from stations, for maneuvering, and for emergency stopping. NTIS PB 224 573.

Thomas TH. CONTROL TECHNIQUES FOR PRT. Railway Gazette International (United Kingdom). January 1974, v130, n1, pp. 14-17.

Around the family of automatic guided transport now known as PRT, control systems have been developed to cope with complex service patterns and closed headways. The author examines these techniques and concludes that, while few have direct application to conventional rail, the same fundamental questions remain to be tackled in heavy rapid transit. An intensively signalled track is justified for PRT on the basis of allowing driverless vehicles. Complex service patterns permit journeys to omit intermediate stations, given appropriate track geometry. Short, off-line stations and a high by-pass ratio are compatible with short headways determined by braking rates and reaction times, while mass rapid transit headways are more often determined by the time taken by a long train to unload, load, and to clear its own length.

- *Electrical Technology*

Geiger JK. Hess WL. ELECTRICAL FEATURES OF THE MORGANTOWN PROJECT VEHICLES, POWER SUPPLY, AND CONTROL SYSTEMS. Institute of Electrical and Electronics Engineers. Transactions of Industry and General Application. March 1973, vIa-9, n2, pp. 248-255.

The Morgantown vehicle electrical system, power distribution and propulsion system, and the control and communications system are described in the context of a demonstration program conducted by Boeing for the Urban Mass Transportation Administration. The projected benefits of a personal rapid transit system, building on the experience gained at Morgantown, are discussed with emphasis on benefits to urban areas through the use of automated electrically-powered systems. Some basic elements of economic analysis and system performance are included. Arguments are presented for immediate deployment of similar systems in urban areas. /Author/

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME III. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 51 pp.

The report covers the measurements of the broadband conducted noise present on and AC power lines feeding the Personalized Rapid Transit (PRT) systems at Dulles Airport with all four systems off. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines prior to the installation and operation of any of the systems. These data will provide a baseline for use in establishing the relative increase in EMI levels

associated with PRT system operation. Data obtained under this effort will enable an evaluation of whether or not existing or potential EMI levels might affect the normal operation of the PRT systems. Such interference could conceivably contribute to breakdown, malfunctions, or safety problems associated with the automated equipment used by the PRT systems in performing normal functions. NTIS PB 233198/1.

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME VIII. DASHAVEYOR SYSTEM. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 35 pp.

The report covers the measurements of the broadband conducted noise present on the AC power lines feeding the Personalized Rapid Transit (PRT) systems at Dulles Airport with each system operating individually. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines and to assess the effect of each system on the power line with all other PRT systems turned off. The measurements obtained during this test will be used for a comparison with data obtained with no PRT systems operating and with all four PRT systems operating simultaneously. NTIS PB-233199/9.

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME IX. FORD SYSTEM. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 29 pp.

The report covers the measurements of the broadband conducted noise present on the AC power lines feeding the Personalized Rapid Transit (PRT) systems at Dulles Airport with each system operating individually. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines and to assess the effect of each system on the power line with all other PRT systems turned off. The measurements obtained during this test will be used for a comparison with data obtained with no PRT systems operating and with all four PRT systems operating simultaneously. NTIS PB 233200/5.

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME X. MONOCAB SYSTEM. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 28 pp.

The report covers the measurements of the broadband conducted noise present on the AC power lines feeding the Personalized Rapid Transit (PRT) systems at Dulles Airport with each system operating individually. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines and to assess the effect of each system on the power line with all other PRT systems turned off. The measurements obtained during this test will be used for a comparison with data obtained with no PRT systems operating and with all four PRT systems operating simultaneously. NTIS PB 233201/3.

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED

RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME XII. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 125 pp.

The report covers the measurements of the broadband conducted noise present on the AC power lines feeding the Personalized Rapid Transit (PRT) systems with all four systems operating simultaneously. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines and to assess the effect, if any, on each individual system with all of the other systems operating simultaneously. Each system is isolated from the main high voltage line by a stepdown transformer which should filter out most unwanted higher frequency spikes. The measurements obtained during this test will be used for a comparison with data obtained with no PRT systems operating and with each system operating individually. NTIS PB 233203/9.

Jamison EE. ELECTROMAGNETIC ENVIRONMENT MEASUREMENTS OF PERSONALIZED RAPID TRANSIT SYSTEMS AT "TRANSPO 72." VOLUME XL. TTI SYSTEM. National Scientific Laboratories, Inc. Final Report. January 1974, Contract DOT-TSC-375, 26 pp.

The report covers the measurements of the broadband conducted noise present on the AC power lines feeding the Personalized Rapid Transit (PRT) systems at Dulles Airport with each system operating individually. The purpose of the measurement effort was to evaluate the electrical environment existing on each of the PRT "hot" and neutral AC power lines and to assess the effect of each system on the power line with all other PRT systems turned off. The measurements obtained during this test will be used for a comparison with data obtained with no PRT systems operating and with all four PRT systems operating simultaneously. NTIS PB 233202/1.

- *Other Technology*

Copsey NR. et al. TRACK DESIGN CRITERIA FOR PRT SYSTEMS IN URBAN AREAS. High Speed Ground Transportation Journal. 76, v10, n1, pp. 59-84.

In London, as in many European cities, the bus services have deteriorated over recent years to a level which many find unacceptable. This has been caused by increasing traffic congestion. The various measures introduced to alleviate the difficulties are meeting with very limited success, and this situation stimulates interest in a possible alternative public transport system. This paper takes a down-to-earth look at the potential of personalized rapid transit systems. A PRT system is regarded as a public transport system with small- to medium-sized vehicles independently controlled and traveling on reserved tracks. First, the idea of the PRT system is viewed against the background of our present urban transport problems and studied in relation to other possible solutions. Then, using the systems approach, planning goals and objectives are developed. The social, economic, and physical aspects of the various alternatives are then evaluated against these objectives. This sets the scene for proposals for arrangement and operation, and suggestions are made for track design.

Hullender DA. Bartley TM. GUIDEWAY ROUGHNESS AS RELATED TO DESIGN

TOLERANCES AND PROFILE CONSTRAINTS. The University of Texas at Austin. Urban Mass Transportation Administration. September 1974, Final Report No. UMTA-TX-11-0001-74-2, 72 pp.

The report addresses the subject of guideway roughness as related to design and construction tolerances and constraints. The approach is to calculate the power spectral densities (PSD) associated with constrained natural terrain irregularities and construction inaccuracies. Both an analytical approach resulting in equations for PSD and a numerical approach calculating PSD based on the fast fourier transform are used. Guidelines are established for constraining the profile relative elevation variations during the initial planning and layout of the desired profile. The degree of degradation in smoothness resulting from random surveying, measurement, and alignment errors during the actual construction is determined. NTIS PB 244073/3ST.

Lavine L. Peterson R. Bulbulian F. VISUAL IMPACT OF PERSONAL RAPID TRANSIT. Minnesota University (Minneapolis). Urban Mass Transportation Administration. November 1974, Final Report No. UMTA-MN-11-0037-74-2, 35 pp.

PRT systems offer on-demand, non-stop service from origin to destination over extensive networks of guideways. To date, these guideways have been portrayed as elevated above grade, minimizing network costs and interference with other circulation systems, but maximizing the visual impact on neighborhoods they pass through. This study does not attempt to present a design solution to these problems, but rather it lays a foundation for developing PRT visual impact design criteria on which future design decisions can be predicted. The key lies in finding effective communications media through which the visual impact of PRT can be conveyed to the public at large. The study explores the effectiveness of three graphic communication techniques. NTIS PB 244459/4ST, DOTL.

Gerrard WL. Caudill RJ. Rushfeldt TR. CRASHWORTHINESS FOR HIGH-CAPACITY PERSONAL RAPID TRANSIT VEHICLES. Minnesota University (Minneapolis). October 1974, Report No. UMTA-MN-11-0037-74-1, 121 pp.

This study is concerned with the design of crashworthy vehicles for high-capacity personal rapid transit (PRT) systems. PRT systems offer on-demand, non-stop service from origin to destination over an extensive network of exclusive guideways. Proposed high-capacity PRT systems operate at fractional second headways. The necessity for such short headway operation has resulted in concern for passenger safety in high-capacity PRT. This study is undertaken to establish guidelines for the design of PRT vehicles in which passengers would not be seriously injured even under the conditions of a worst-case collision. It is established that, even in the case of a collision with a fixed unyielding barrier, adequate passenger protection can be obtained using existing technology, provided impact velocities do not exceed 30 to 40 mph.

TRANSIT TERMINAL DESIGN

- *Design Considerations*

Fausch PA. Dillard DE. Hoffmeister JF, III. EVALUATION TOOL FOR DESIGNING PEDESTRIAN FACILITIES IN TRANSIT STATIONS. Transportation Research Record. 74, n505, pp. 31-42.

This paper describes the Urban Mass Transportation Administration station simulation package -- a model for evaluating transit station designs to determine whether a given layout achieves the design objectives of providing enough space for pedestrian movement, providing enough service facilities, and connecting these areas and facilities in the most efficient manner. To determine this, the package provides pedestrian occupancy data in all movement and queue areas; walk times, time in queue, and total times for specific areas, partitions, or the entire length of the station; and distribution of the previous variables for comparison with level-of-service standards. The model user converts a station building layout into nodes, links, and areas that represent queue devices or decision points, pedestrian paths between these devices or points, and the area associated with these devices and paths. The model simulates the flow of pedestrians along the links that represent the station and accumulates appropriate data.

Fruin JJ. ENVIRONMENTAL FACTORS IN PASSENGER TERMINAL DESIGN. American Society of Civil Engineers Journal, Transportation Engineering. February 1972, v98, nTE1, Procedure Paper 8734, pp. 89-101.

A passenger terminal may be visualized as a local subsystem within a large regional system that exists to support the needs of society. The local terminal subsystem has external effects related to its impact on the community and regional system and internal effects related to its impact on the user. Internal and external environmental design elements also tend to overlap in some areas. Aesthetics is an example of an element that has both internal user impacts and external community impacts. The primary elements of the external terminal environment are land use, the efficiency and configuration of the terminal's access systems, its aesthetic and socioeconomic impact on the community, and its effects on the health, tranquility, and natural ecology of the surrounding area. Internal environmental design elements are comprised of both objective and subjective factors including service standards, traffic characteristics, visual design, patron services, comfort and convenience, and maintainability.

Vuchic VR. Kikuchi S (Pennsylvania University, Philadelphia). DESIGN OF OUTLYING RAPID TRANSIT STATION AREAS. Transportation Research Record. 74, n505, pp. 1-12.

Design of modern rapid transit stations in outlying areas is a complex process that has had only limited documentation. The paper attempts to help the designer in organizational and technical aspects of his or her work. Steps in the design procedure are outlined, and data needed for design are listed. The designer's work starts with an analysis of the

requirements of the three interested parties: passengers, transit system operator, and community. Design principles and standards emphasize priority sequence for different access modes: pedestrians, feeder bus, kiss-and-ride, and park-and-ride. Maximum separation of modes is desirable: bus stops should be close to the station entrance, preferably in a separate transit area; kiss-and-ride should be next in distance from the station; park-and-ride should be in the farthest areas. Design should be such that the maximum concentration of automobile traffic is on the periphery of the station, since close-in areas have pedestrian concentrations. Safe and convenient pedestrian movement must be provided for throughout the station area. Examples of design elements for each mode are presented. Finally, the paper contains several examples of total designs of different types of stations.

PROTOTYPE SUBURBAN TRANSPORTATION CENTERS. Northeastern Illinois Planning Commission. March 1971, Project No. Ill-t9-2.

The purpose was to develop criteria for prototype commuter 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 developed 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 as 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. Three prototype transportation center designs were developed for application in different types of urban and suburban locations. Estimated cost factors for each prototype design are provided. The possible impact of new transit technology on future station configurations is discussed. A final section details implementation procedures for commuter transportation centers. Different sources of financing are examined with reference to local contributions, parking fees, commercial leases or land sales, and participation in relevant federal assistance programs. NTIS SP 204 931, HRIS 84 223064.

Bishop HL. URBAN MASS TRANSPORTATION TERMINALS (COMMITTEE 14 -- YARDS AND TERMINALS). American Railway Engineering Association Bulletin. October 1972, v72, n639, pp. 24-28.

It is noted in an introductory paragraph that the "go" system in Toronto has been specifically designed to attract auto users and operates on a $2 million subsidy, which is considerably cheaper than the highways that would have to be built to carry the same number of persons. However, the fare revenues are generally expected to meet the operating and maintenance costs. The remainder of the article, which constitutes a report of the association's committee on yards and terminals, deals with service and storage yards for rapid transit passenger cars, stations and terminals (landscaping, general design, interior traffic flow, and waiting room size

as parts of a typical station development plan, and site selection factors), vehicular parking at stations, and rail access to airports.

STUDY OF TERMINAL TRANSFER FACILITIES IN CONJUNCTION WITH URBAN FREEWAYS. Clearinghouse Federal Science and Technical Information. DeLeuw, Cather and Company. June 1967.

The results of an investigation indicate that a terminal-transfer facility could be construction using air rights over an expressway. The structure could be designed to serve both park-and-ride and kiss-and-ride users, downtown shuttle bus and rail rapid transit operations, local buses, long distance buses, and, possibly, a highway department's freeway maintenance and patrol activities. Because accommodations of rail rapid transit vehicles would require modifications in the design, only buses were contemplated. Access from and exit to freeway lanes could be designed in a way to relieve congestion in the section of the freeway served. Attractive shuttle bus service with close headways could be maintained during peak hours. Rail rapid transit to the central business district should be considered in major transportation corridors. The study postulated transfer terminals in intermediate areas sufficiently close to downtown districts to intercept a large number of potential users, yet far enough removed to avoid areas of serious traffic congestion./Author/

Leisch JP. NEW CONCEPTS IN RAIL-BUS INTERCHANGE. American Civil Engineers Journal of Transportation Engineering. February 1974, v100, nTE1, Procedure Paper 10328, pp. 103-119.

To plan and design a bus-rail mode-transfer facility within a freeway interchange of a transit-freeway transportation corridor, planners and engineers must consider the integration of all transportation facilities. In particular, attention should be paid to the relationship of traffic access location and the freeway interchange; interchange-intersection traffic operational efficiency; and mode-transfer facility access concepts and internal circulation concepts. Major cities in North America have constructed multimode transportation corridors, and with them has come the need to provide good access and efficient bus-rail intermodal transfer developed on sound planning, design, and operational concepts. To establish these concepts, "Planning Considerations" are presented, including interchange configuration influencing mode-transfer facility location and access; multimode transportation corridor system design; integration with arterial street systems; and bus, auto, and passenger traffic generation./Author/

Nathenson R. PERSONAL RAPID TRANSIT STATION DESIGN. Department of Mechanical Engineering. Massachusetts Institute of Technology. June 1972, 121 pp.

For transportation systems, the stations form the indispensable link between the society and the system itself. Yet, for personal rapid transit systems, little quantitative work has been done on the station design. This paper enumerates some commonly mentioned station designs and suggests several others. Values of important parameters for each design are calculated. A comparison of station types reveals that the linear bay

arrangement is, overall, the most desirable. Most like a conventional station, the linear bay arrangement for personal rapid transit systems offers the shortest in station time and needs the least land area.

TERMINAL FACILITIES MASTER PLAN. Metropolitan Dade County Planning Department. December 1968, Project No. Fla-t9-1.

The report examines existing multimodal terminal facilities in the Miami, Florida metropolitan area, projects future requirements, develops criteria for expansion, and makes specific recommendations for terminal development planning. The report represents one of five transportation master plans for 1985. The modes evaluated are trucks, railroads, intercity buses, and automobiles. A comprehensive inventory is made of existing terminal facilities and operations, broken down by mode. Four basic criteria for long-range terminal development 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, several basic design standards are suggested for site selection, user amenities, integration within the extant urban system, and noise and air pollution. A framework for implementation is developed which will accommodate technological and regulatory changes in the operations served by urban terminals. Estimates of future requirements are developed principally on the basis of projected increases in population and land use. NTIS PB 184 729, HRIS 84 207917.

- *Park-and-Ride Lots*

Frost M. PARK-AND-RIDE: A RISING TIDE. Public Works (New Jersey). September 1974, v105, n9, pp. 82-84.

Examples of successfully operating fringe parking lots for commuter park-and-ride bus and train passengers are examined. Experience has indicated that potential locations should be large enough to provide between 500 and 1000 car spaces to ensure economical operation of buses during peak hours. Commuters' parking and walking habits have been surveyed, and criteria are included here to ensure safety and continued usage of these lots. Communications between riders and management of the lots and between riders and vehicle operators are features which enhance patronage.

PARK-AND-RIDE RAIL SERVICE -- JERSEY AVENUE STATION, NEW BRUNSWICK, NEW JERSEY. Tri-State Transportation Commission, New York, New Jersey, and Connecticut. May 1967, Project No. Int-mtd-1.

A mass transportation demonstration project at New Brunswick, New Jersey was designed to test whether a new railroad station at the outskirts of a developed suburban community would attract new patrons to an existing carrier and, at the same time, divert passengers from the suburban city center station, thereby relieving local vehicular traffic congestion. Results of the experiment revealed that an outlying station with ample parking space will attract new patrons to rail service, but its attraction will be limited by the availability of direct, convenient auto access

routes from surrounding residential areas. The extent to which an outlying station, even with free parking, will attract passengers away from the suburban city center station is conditioned by the frequency of train service at the outlying station as contrasted with the center station. NTIS PB 174 740, HRIS 84 085546.

Gatens DM. LOCATING AND OPERATING BUS RAPID TRANSIT PARK-AND-RIDE LOTS. Transportation Research Record. 74, n505, pp. 21-30.

This paper reviews and synthesizes previous experiences with locating and operating park-and-ride lots throughout the country. The data included represent the experience of seven municipalities and account for approximately 4500 park-and-ride spaces in 13 lots serving as change-of-mode facilities for bus transit. The characteristics of the lot users were investigated. Data were analyzed to determine the characteristics of trip length, trip times, trip purpose, type of employment, trip origin, and mode to bus. Further considerations included mode of travel to work before the establishment of park-and-ride lots and environmental impact factors. From the analysis of data gathered, some preliminary and general planning guidelines relevant to the location and sizing of a park-and-ride facility in an urban transportation corridor were developed.

Abdus-Samad UR. Grecco WL. Alter CH. PREDICTING PARK-AND-RIDE PARKING DEMAND. Highway Research Record, Highway Research Board. 73, n499, pp. 45-62, 8fig, 7tab.

This study is concerned with the determintation of design criteria for prediction of parking demand at park-and-ride facilities in medium- to large-sized cities in the United States. Ninety-three change-of-mode parking facilities in 10 cities were used in the study. Data were collected through a mail survey. The report includes an analysis of important physical, operational, and locational characteristics of change-of-mode parking facilities experienced by 26 agencies operating 73 rail and 20 bus facilities. The change-of-mode demand is estimated through a prediction equation developed by linear regression analysis. The prediction model was tested for its applicability by using separately supplied data from a committee of the Institute of Traffic Engineers. Input to the model consists mainly of characteristics of the city, the transit system, and the location of the parking facility.

PARK-AND-RIDE/PARK-AND-PADDLE FEASIBILITY STUDY. Urban Transportation Planning Association, Inc. 73, Final Report No. UMTA-LA-09-0003-73-1, Contract LA-09-0003, 262 pp.

New Orleans' central business district (CBD) is separated from the city's major residential areas by the Mississippi River. The major conduit into the city is the greater New Orleans Bridge, which is supplemented by ferry service. The purpose of the study was to develop and evaluate proposals to alleviate rush-hour traffic congestion on the bridge. In order to prepare viable alternatives to the present situation, the authors conducted on-the-spot surveys of auto, bus, and ferry commuters to determine: how many there are; of these, how many were commuting to work; where they were going and why they were using that mode of transportation. Park-and-ride

and express bus and carpool lane programs in other cities were examined. An analysis was made of such factors as: the pattern of trip distribution between the Westbank area and the CBD; average daily parking fees in New Orleans as well as in other cities; the merits and drawbacks of other alternatives such as personal rapid transit; and availability and cost of suitable park-and-ride lot sites. The goals to be met by any new program were established. The alternatives were ranked according to degree of goal achievement. Cost-effective analysis for each alternative was made and the subsequent choice of park-and-ride as well as capital estimates are detailed. Finally, supplemental recommendations are made. These include the eventual implementation of a park-and-paddle system for ferry riders. An extensive collection of maps and charts, as well as a lengthy bibliography and appendices including the commuter questionnaires, are included. NTIS PB 229 750/AS.

Christiansen DL. Grady DS. Holder RW. PARK-AND-RIDE FACILITIES: PRELIMINARY GUIDELINES. Texas Transportation Institute. August 1975, Report No. TTI-2-10-74-205-2, 56 pp.

This report presents a preliminary evaluation of park-and-ride facilities. A literature review was conducted and, from this, characteristics of park-and-ride service in the United States were documented. Also, each Texas city providing park-and-ride service was surveyed, and the existing or projected park-and-ride operations in five Texas cities are documented. Based on the review of these data, preliminary guidelines that can be used in planning park-and-ride facilities are discussed.

- *Operations*

TRANSIT FACILITIES AND OPERATIONS -- VOLUME 3: TRANSPORTATION CENTER. Simpson and Curtin. November 1970, Project No. Ny-t9-5.

The requirements for the feasibility of designing a transportation terminal for downtown Utica, New York are examined. Its primary function would be to serve as a point for modal interface at which the variety of transit operations serving Utica could be coordinated. At present, there is inadequate coordination of intercity bus and rail carriers which serve Utica and the city's public transportation systems. The terminal for the primary mode of intercity public transportation, the motor coach, is inadequate and deteriorated. The railroad station is completely adequate but underutilized. 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 instituted. Several criteria for a transportation center are discussed and applied to the city's two existing transportation terminals. Detailed recommendations are made converting the railroad terminal into a multimodal transportation center. NTIS PB 197 952.

Vigrass VW. PATCO'S EXPERIENCE WITH UNMANNED STATIONS AND AUTOMATIC FARE COLLECTION SYSTEM. American Transit Association. April 1972, 8 pp.

Port Authority Transit Corporation (PATCO), the operator of the Lindenwold high-speed line, is the first transit corporation to use an automatic fare

collection system with unattended stations. Later, roving attendants were added to check on malfunctioning equipment, etc. The system for each station consists of (1) an entry/exit gate that magnetically reads encoded tickets, (2) a mechanical ticket vendor, (3) a changemaker, (4) a transfer ticket vending machine, (5) a transfer validator for return trip tickets, (6) a closed circuit television surveillance system, (7) a call-for-aid telephone, and (8) a separate accounting procedure. In addition, PATCO has its own police force with the power to arrest in both Pennsylvania and New Jersey; people have been prosecuted for vandalism, fare evasion, disorderly conduct, and other more serious offenses.

COMPARISON OF TRANSIT FORMS

- *General Considerations*

Ford BM. PARAMETRIC ANALYSIS OF GENERIC URBAN TRANSIT SYSTEMS. Johns Hopkins Applied Physics Laboratory. December 1967, Project No. Trd-43.

Five generic transit systems are considered to determine: (1) relationships among operational parameters (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. The five systems, all of which presuppose a grid or network of automated guideways placed extensively throughout an urban area, are: (1) demand-responsive systems with small-car vehicles to provide direct, point-to-point service; (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 (local and express) scheduled network systems; and (5) hybrid network systems which provide dual-mode service (demand-actuated and simple or two-class scheduled). The analysis delineates optimal station spacing, grid spacing, mean headways, line speeds, trip times, line capacity, vehicle characteristics, investment costs, and annual operating costs. Guideway costs represent the major economic barrier to implementation. NTIS PB 188 984.

Ferreri MG. MASS TRANSPORTATION: THE HARDWARE. Highway Research Record, Highway Research Board. 70, n318, pp. 20-26.

Selection of a transportation system is an iterative process encompassing three steps: establishment of system requirements on the basis of the functions and performance demanded by potential patrons, analysis of existing or advanced-development systems in the light of system requirements, and systhesis of the optimal mode mix. Hardware to meet urban transportation needs falls largely into three categories: improved and sophisticated conventional rail systems, monorail and rubber-tired duo-rail train systems like Safege and the Westinghouse transit expressway, and small vehicle computerized systems for short-haul or demand-actuated transportation. Universal parameters, costs, and available hardware configurations are examined.

Sawicki DS (Wisconsin University, Milwaukee). BREAK-EVEN BENEFIT-COST ANALYSIS OF ALTERNATIVE EXPRESS TRANSIT SYSTEMS. Journal of Transport Economics and Policy. September 1974, v8, n3, pp. 274-293.

The City of Milwaukee commissioned research into the comparative merits of its existing freeway flier express bus system, a controlled access system giving the flier right-of-way and restricting the access of cars on congested roads, and a busway with its own right-of-way. The purposes of the research were: first, to determine the economic rationale in terms of benefits and costs of building a rapid transit busway; and, second, to determine the break-even demand points where the benefit cost ratio of

alternative systems became better than the busway. Only the costs of the line-haul portion of the system were considered in the analyses and these costs included elements for both operating and capital costs. At various levels of demand, for each of the three systems, five different modal splits were considered, ranging from 2.5 percent of all passengers using bus and 97.5 percent using cars (the present case) to 75 percent of all passengers using bus and 25 percent using cars. The results show that, at the present levels of demand, the existing system is the best and the busway system a very poor third; but, if the predicted increase in bus travel takes place, the controlled access system is more likely to be the best alternative. The application of the results to other locations is discussed.

Fredland DR. Visintainer A. THE EFFECT OF INFLATION AND REAL INCOME GAINS ON CHOICE OF MODE FOR URBAN RAPID TRANSIT INVESTMENT. Florida State University, Urban and Regional Planning Department. Final Report No. UMTA-FL-11-0003-73-2, 87 pp.

This report considers the differential financial effect that inflation and income can have on capital-intensive and labor-intensive approaches to mass transit such as rail and express bus service. It is the opinion of the authors that the effect of these factors has not been well studied. The study employs a 16-mile hypothetical transit corridor serving 30 million passengers a year, which is costed for both rail and express bus. Cost and revenue factors are inflated using a range of assumptions. Ridership and trend assumptions are also varied. Net present values of revenues minus costs (including amortization) for 30 years of operation are then estimated in cash terms and compared. It was found that bus operation is more sensitive to real wage increases, and less sensitive to inflation and to ridership levels. The financial variant for buses was considerably less than for rail which, added to the shorter time needed to institute bus service and the greater flexibility of buses, would, according to the authors, place in question the wisdom of the current trend toward rail rapid transit. Various illustrative tables and figures are included. NTIS PB 226 855/AS.

PUBLIC AND MASS TRANSPORTATION FOR TEXAS: A REFERENCE MANUAL. Texas Transportation Institute, Texas A&M University. February 1976, 249 pp.

The manual serves as a concise resource on mass and public trnasportation for Texas. Overview of transit is traced from periods of historical development through comparisons of current technologies. Operating characteristics of various modes as well as planning and evaluation criteria of transportation systems are examined. Additional resource material is cited.

Sanders, DB., Reynen, TA. (DeLeuw, Cather, and Company). CHARACTERISTICS OF URBAN TRANSPORTATION SYSTEMS--A HANDBOOK FOR TRANSPORTATION PLANNERS. Report No. URD-DCCO.74.1.4, 111 pp.

Composite of various tools and methodologies used by transportation planners and urban specialist in evaluating performance characteristics of conventional transportation systems. Three modes are evaluated: rail, bus and highway (automobile and mixed mode). Description of each mode is organized around seven selected parameters: speed, capacity, operating cost, energy

consumption, pollutant emissions, capital costs, and accident frequency. Additionally, each mode has a corresponding appendix section where the parameters are evaluated in further detail and for specific geographic areas. Two other appendix sections and a general bibliography provide additional information.

- *Bus versus Rail*

Myers ET. ATTACK BY CHARLATANS. Modern Railroads. November 1974, v29, n11, pp. 68-70.

Rail transit has found its enemies in the zealous advocates of buses and automobiles. The proponents of these two modes of transportation claim that the construction of rail transit is too costly and time consuming. They set out to prove the efficiency of buses over rail transit; but, since the fuel consumed by buses and cars is in short supply, it seems likely that a transit system dependent upon central station generation of power is more likely to win out. Bus transportation is labor-intensive and rail transit is capital-intensive, a fact which has been used to promote bus transit. However, where a great volume of riders exists, capital-intensive systems are more of an economic advantage. Other factors besides cost must also be considered in choosing the most suitable transit system. Supporters of bus and auto transportation insist that rail transit will be unable to attract riders, but facts have shown otherwise: BART has attracted thousands of riders and has reduced automobile use. It is not too soon to start building transit systems that will alleviate the problems of the 1980's. Costs will continue to rise, so long-term planning will prove to be the better solution in the long run. The ultimate solution is a carefully planned, community responsive mix of buses, cars, and rail transit systems.

Deen TB. James DH. RELATIVE COSTS OF BUS AND RAIL TRANSIT SYSTEMS. Highway Research Record, Highway Research Board. 69, n293, pp. 33-53.

There is a growing need for information on the relative costs of bus and rail systems for providing rapid transit service. Rapid transit is here defined as transit operating on its own exclusive right-of-way. The first step in comparing bus and rail costs is to analyze the various methods suggested for operating busway systems. This was done by comparing the relative service and costs associated with four separate operating patterns. The sensitivity of the conclusions was tested to determine the effect of line length, passenger traffic patterns, feeder bus route length, station spacing, and other variables. It appears that no particular operating method is inherently superior to any of the others. Any one method may be superior in a particular instance, depending on the operating environments and conditions that must be met. The bus and rail costs can then be compared with assurance that the analysis is not distorted by the method of bus operation selected or, at least, with insight into the direction and magnitude of the bias. Hypothetical bus and rail systems were described so that each provided identical services. Relative costs for providing the service vary, depending on line length, proportion of the line requiring subways, and passenger loadings. Sensitivity of costs to rising wage rates and variable interest rates was

also examined. Rail systems can demonstrate cost superiority where peak-hour passenger volumes exceed 12,000 and/or where more than 20 percent of the system requires subways. At volumes of 4000 peak-hour passengers and where no subways are required, buses show cost superiority./Author/

Hoffman GA. INTERMEDIATE LEVELS OF TRANSIT SERVICE -- WHICH ARE COSTLIER: TRAINS ON RAIL OR BUSES ON BUSWAYS? American Society of Mechanical Engineers. September 1973, Technical Paper 73-1CT26, 9 pp.

Trains on rails are cost-equivalent to buses on busways where the newly installed urban transportation system's capacity is 12,000 passengers per hour per direction. New transit facilities, utilizing existing railroad air rights, require capacity improvements of 7.5 (busway) to 13 (trains on rail) million dollars per mile and cost to operate from 1.2 (bus) to 0.4 (trains) cents per seat-mile, using 1970 data. Transit cost estimates for future vehicles of advanced technology design indicate modal equivalence at volumes of 20,000 passengers per peak hour.

Miller DR. et al. COST COMPARISON OF BUSWAY AND RAILWAY RAPID TRANSIT. Highway Research Record, Highway Research Board. 73, n45, pp. 1-12, 5fig, 4tab, 8ref.

Costs of bus on busways and train rapid transit systems were compared at varying passenger capacities on hypothetical new routes, using both current and future vehicle equipment. The calculations indicated that fast transit service could currently be provided at comparable costs by either buses or trains at about 2000 to 5000 per peak hour, based on equipment and facilities of recent design. Improved or enlarged designs of current bus and transit equipment tend to shift the bus-train equivalence or crossover region another 1000 or 2000 passengers per hour and to somewhat reduce the modal differences in costs between bus and train below that capacity. Above these capacities, rail systems provide lower total costs. The study concluded with a prognosis of future developments in transit and bus technology that will enhance the quality of service while affording some possibilities for cost reduction.

Vuchic VR. Stanger RM. LINDENWOLD RAIL LINE AND SHIRLEY BUSWAY: A COMPARISON. Highway Research Record, Highway Research Board. 73, n459, pp. 13-28, 4fig, 3tab, 11ref.

Comparisons of different transit modes have seldom given sufficient attention to service parameters. Rather, costs were compared for modes that optimally provide different types of operations. This study utilizes two existing systems for a comprehensive comparative study of bus and rail technologies and their different types of operations. It differs from previous studies in two respects. First, it performs the analysis on two actual systems and, thus, does not utilize any hypothetical assumptions. Second, it includes more system characteristics than any of the previous studies. The Lindenwold "High-Speed Line" offers all-day, high-frequency, reliable service among its 12 stations; it depends heavily (80 percent) on access by automobile. The Shirley Busway provides mostly peak-hour service on many lines with different routings, but with a lower frequency and reliability than Lindenwold; it relies mostly (84 percent) on access by walking. Lindenwold required very high investmsnt and was completed as one project; its revenues exceed operating costs by a significant

amount. The line is extremely well operated and managed. Shirley was introduced with considerably lower investment, but it requires at least a three to five times higher labor force per passenger than Lindenwold. Its revenues closely cover the operating costs. Shirley can be improved by the introduction of all-day, high-frequency service on some of its routes. The main deficiency of the busway concept will remain street operation in the central business district. Both systems are very successful. Their attraction of new riders proves that there is a considerable latent demand for transit, even in low-density auto-oriented suburban areas, and an underutilized potential of modern bus and rail modes.

- *Site Specific Comparisons*

Morris WH, Jr. COMPARISON OF BUSWAY AND LIGHT RAIL MODES. Transportation Research Board Special Reports. 75, n161, pp. 50-61.

Much has been offered to convince decision makers that busways are the least costly of fixed-guideway services in medium-density urban corridors. Until recently, these claims could be questioned, but not refuted, because a thorough analysis of comparable busway and light rail transit (LRT) systems did not exist. However, such a work was completed in late 1974. The Rochester, New York, Charlotte-Henrietta corridor studies are a detailed busway versus LRT mode comparison for a specific corridor. The studies show that, although LRT and busway investment costs are similar for equal facilities, LRT exhibits substantial operating costs and operation and service advantages.

PLANNING MODE SELECTION AND ECONOMIC FEASIBILITY REPORT -- CHARLOTTE-HENRIETTA TRANSIT CORRIDOR. VOLUME I: PLANNING AND PRELIMINARY MODE SELECTION. Urban Mass Transportation Administration, Rochester-Genesee Regional Transport Authority Technical Study (New York). February 1964, Contract No. UMTA-NY-090006-74-1, 318 pp.

The purpose of this report is to provide the necessary documentation by which an evaluation may be made of the economic and technical feasibility of the proposed Charlotte-Henrietta Rapid Transit System in Rochester, New York. The Charlotte-Henrietta Corridor is unique in that the proposed right-of-way is predominantly along existing railroad lines, thus minimizing the problems of land acquisition, relocation of residences and businesses, and the interference with existing transportation systems during construction or after implementation. The rapid transit system is also being designed to permit the continuance of existing freight service during nighttime operations without interference to passenger operations. Presented are an analysis of present conditions, the determination of future transit requirements, and an initial analysis of alternative transportation systems. Requirements for rapid transit are based on population projections, employment projections, existing land use, proposed land-use plans, patronage projections, and resultant service characteristics. The three alternative rapid transit modes which best satisfy all of the criteria established for Rochester were the grade-separated conventional rail, light rail, and busway systems. Appendices include description of existing railroad lines, models and projections, initial transit system design, and a theoretical concept for obtaining qualitative measures of mode effectiveness. Figures, tables, maps, and photographs are numerous.

PLANNING MODE SELECTION AND ECONOMIC FEASIBILITY REPORT -- CHARLOTTE-HENRIETTA TRANSIT CORRIDOR. VOLUME II: MODE SELECTION AND ECONOMIC FEASIBILITY. Urban Mass Transportation Administration, Rochester-Genesee Regional Transport Authority, New York State Department of Transportation, Corddry Carpenter Dietz and Zack. October 1974, Contract No. UMTA-NY-09-0006, 259 pp.

The document provides a comprehensive economic analysis of the three selected alternative rapid transit systems for the Charlotte-Henrietta Corridor. The results of this analysis indicate the economic feasibility of an optimal system and lead to the recommendation of a specific mode. Requirements for implementing the most feasible rapid transit system in the Charlotte-Henrietta Corridor at the earliest possible time are identified. See also v1, PB 232 347 and v2/app, PB 238 916 prepared by Corddry Carpenter Dietz and Zack, Rochester, New York. NTIS PB 239806/3SL, DOTL.

PLANNING MODE SELECTION AND ECONOMIC FEASIBILITY REPORT -- CHARLOTTE-HENRIETTA TRANSIT CORRIDOR. VOLUME II -- APPENDICES. Corddry Carpenter Dietz and Zack, Engineers. November 1974, Technical Study No. UMTA-NY-09-0006-74-2, 130 pp.

This report contains the appendices to "Planning Mode Selection and Economic Feasibility Report -- Charlotte-Henrietta Transit Corridor. Volume I: Planning and Preliminary Mode Selection." The purpose of Volume I was to provide the necessary documentation by which an evaluation may be made of the economic and technical feasibility of the proposed Charlotte-Henrietta Rapid Transit System in Rochester, New York. The Charlotte-Henrietta Corridor is unique in that the proposed right-of-way is predominantly along existing railroad lines, thus minimizing the problems of land acquisition, relocation of businesses and residences, and the interference with existing transportation systems during construction or after implementation. The rapid transit system is also being designed to permit the continuance of existing freight service during nighttime operations without interference to passenger operations. Appendix A, "Light Rail Alternatives," discusses grade crossing in the vicinity of terminals, extension of service to Kodak Park, the Lake Ontario Extension, and a summary of light rail alternatives. Appendix B, "Busway Alternatives," considers bus capacity, the ability of transit buses to leave exclusive busway, express bus service, grade crossing in the vicinity of terminals, Lake Ontario Extension, bus life analysis, intercorridor mode compatibility, and a summary of busway alternatives. Appendix C includes specific work items recommended for preliminary engineering and design; plan and profile drawings compose Appendix D.

A PROPOSED PUBLIC TRANSPORTATION SYSTEM FOR THE PORTLAND-VANCOUVER METROPOLITAN AREA. Columbia Region Association of Governments. August 1973, Contract No. UMTA-IT-090008-73-1, 39 pp.

Summary report was prepared for distribution throughout the Portland-Vancouver metropolitan area to inform citizens of the aspects of the proposed public transportation system. It is the result of a two-year

study which analyzed alternative concepts of providing public transportation service throughout the Portland-Vancouver metropolitan area. It was concluded that the community should greatly expand its public transportation service through the development of a bus rapid transit system utilizing exclusive transit lanes, roadways, and park-and-ride stations. It was also decided that all facilities should be designed to allow for future conversion to an automatically operated transit system on fixed guideways with off-line stations when it becomes technologically feasible. The system recommended in this report would provide the community with high-speed, convenient, and attractive public transportation connecting residential areas to centers of employment, commerce, education, culture, recreation, and community services. Specific features include: 160 miles of express routes with 22 miles of exclusive transit roadways and 15 miles of reserved bus lanes; 75 express bus stations and stops with total parking for 15,000 automobiles; 1000 sheltered waiting areas; conversion of certain streets in downtown Portland to exclusive transit malls with wide sidewalks and pleasing architectural treatment; 1000 advanced concept designed, air-conditioned buses by 1990; a major downtown transit station which would be part of a multimode transportation terminal; exclusive transit roadways which could later be converted to automatically controlled fixed guideway systems; and frequent shuttle service in the downtown area. NTIS PB 226 521/AS.

BIRMINGHAM RAPID TRANSIT STUDY. Traffic Engineering and Control (United Kingdom). July 1971, v13, n3, p116.

The potential for developing public rapid transit networks in the Birmingham area was examined. Four alternate systems of public transport were evaluated: bus rapid transit, rail rapid transit, suburban rail, and express bus services. Five corridors are considered feasible and the most promising systems are listed for each.

ST. LOUIS METROPOLITAN AREA -- RAPID TRANSIT FEASIBILITY STUDY LONG-RANGE PROGRAM. Parsons Brinckerhoff Tudor Bechtel. August 1971, Project n Intt9-4.

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. 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 were conducted. Phase II was concerned with the anticipated future growth of the area and changes in its socioeconomic characteristics that are likely to affect transit requirements; development of public transport system policies; and an evaluation of conventional and alternative future transit systems. In accordance with the decisions 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-like) system operating on grade-separated exclusive right-of-way. The early portion of Phase III consisted of an analysis and presentation of the advantages and disadvantages 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 investigation 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 socioeconomic 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. A continuing public transportation planning effort should 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 PB 204 060.

THE RAPID TRANSIT PLAN FOR THE METROPOLITAN SEATTLE AREA -- TECHNICAL APPENDIX. DeLeuw Cather and Company. Project No. Wash-t9-1.

The report is a detailed technical appendix to the long-range transit planning study for metropolitan Seattle in 1985. Sixteen criteria for evaluating proposed transit systems are advanced which emphasize capacity, performance, and urban ecology. Twenty-nine potential transit systems were then evaluated. Based upon the resulting data, the authors synthesized four potential transit alternatives for implementation. These included: (1) buses in mixed traffic; (2) buses on metered freeways; (3) grade-separated busways; and (4) a dual-mode bus and rail system. Comparative estimates of revenues, operational and capital costs, trip times, and ridership were employed to yield the optimal system. The authors recommend adoption of the fourth alternative. The report contains a transportation corridor analysis designed to locate desirable routes for transit operations. Specific design standards are also advanced for the vehicles, stations, and guideways. Economic factors are examined at length. An implementation program is also discussed which will require a regional transportation authority supported by public funding. A detailed cost-benefit analysis is included. Finally, the report documents results of urban design studies to calculate the effects of the community of transit, environmental and societal effects of alternative transit systems, and the impact of transit on the metropolitan area. The authors conclude that transit construction will be a stimulus to land use development, provided that effective ecological controls are maintained.

A LONG-RANGE OF TRANSIT IN NASHVILLE. Alan M. Voorhees and Associates, Inc. September 1971, Project No. Tenn-t9-2.

The analysis focuses on systems which employ exclusive guideways and advanced technology to provide express service within an urban area. An analysis of potential transit system implications is contained from which basic selection criteria are developed. Four categories of such implications are examined, including: (1) resource allocation; (2) urban environment; (3) urban mobility; and (4) urban structure. Individual analyses of potential concepts are outlined in detail for conventional large- and small-vehicle systems. Conventional designs include buses (standard, articulated, double-deck, or minibuses on exclusive right-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 employe two- to four-passenger gondolas moving on an automated guideway. Each system is described in detail. 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. Improved surface bus service is recommended in conjunction with long-range land-use planning. NTIS PB 204 948.

PLANNING FIXED-WAY TRANSIT SYSTEMS

- *Planning Techniques and Methodology*

Fox JN. PROCEEDINGS OF THE SYMPOSIUM ON REGIONAL PUBLIC TRANSPORTATION. The University of Texas at Arlington, Urban Mass Transportation Administration. July 1974, Contract No. UMTA-TX-11-0001-74-1, 89 pp.

The contents include discussion of: integrating highway and transit plans for the region; Dallas area transit plan; Fort Worth transit plan; research results on metro area public attitudes; evaluation of rail rapid transit and express bus service in the urban commuter market; financing alternatives for urban public transit. NTIS PB-243654/1ST, DOTL.

Quinby HD. SOME PLANNING AND DESIGN ASPECTS OF RAPID TRANSIT. Institute of Traffic Engineers. 39th Annual Meeting. August 1969, 15 pp.

The conditions and needs for rapid transit vary widely between different urban regions, different parts of these regions, and at different stages of the areas' development. Rapid transit planning must be susceptible to possible broad scope and levels of performance. The following key characteristics are important in modal interrelationships: (1) linear spacing of stations and interchanges; (2) practical average running speeds; (3) effective range of trip-lengths served; (4) capacities; (5) capital and operating costs; and (6) environmental impact on the community. The following relationships are discussed which have significance in selecting the proper rapid transit system: (1) the local urban surface transit system; (2) the regional highway and street system; and (3) superregional or megalopolitan transportation consideration. Since usually both rapid and surface transit systems are planned to provide frequent service, especially during peak periods, the relative headways may not always be a dominant factor in planning coordination between rapid and surface transit physical facilities. The relative capital and operating costs of rapid and surface transit will strongly influence their economic viability. The planning interrelationships between rapid transit and the regional highway and street network are discussed. Traffic engineers are particularly interested in the following design aspects: (1) change of travel mode; and (2) transit distribution within major urban downtown centers. Coordinated highway-transit interchange stations, employing several access modes, should be compactly designed to minimize spatial requirements and in-station transfer time. Station layouts must provide adequate circulation, parking, and other facilities required for flexible multi-access service. All-weather station protection of passengers is necessary. Opportunities for utilizing air rights over rapid transit stations must be fully considered in station planning and design.

Jessiman WA. et al. A RATIONAL DECISION-MAKING TECHNIQUE FOR TRANSPORTATION PLANNING. Highway Research Record, Highway Research Board. 67, n180, pp. 71-80.

Evaluation of transportation improvements by conventional benefit-cost analysis raises the problem of trying to evaluate benefits or costs which

cannot readily be converted to dollars and cents. Sometimes these benefits are neglected. Sometimes they are converted to dollars no matter how crude the estimate. Most often they are merely qualitatively weighed in the mind to determine whether or not they are sufficient to alter the decision recommended by the economic analysis based on the quantifiable factors. To help in these situations, a technique or framework is presented which would treat all pertinent factors more rationally and systematically. Examples are presented showing the results of the technique at each intermediate step. An extension of the technique is made to consider a system of possible projects and the optimal allocation of available capital among them. This extension results in a problem which may be solved by integer linear programming techniques. The formulation of this linear program is also shown.

Smith KV. Phillips CT. Lewis RJ. NETWORK EVALUATION OF COMPLEX TRANSPORTATION SYSTEMS. Rand Corporation. October 1970, n4470, 15 pp.

The proposed methodology studies transportation system effectiveness by evaluating a complex system of inter- and intracity travel modes, including access, egress, and transfer services, within a geographic region. Such a system can be viewed as a network of nodes (cities) and links (travel modes). The methodology is illustrated in terms of a single user group -- middle-income people on business trips -- without considering access and egress. Each link is described by type, schedule, and capacity, as well as by its positive and negative attributes perceived by users, such as travel time and cost, safety, convenience, and comfort./Author/

Maltby D. Chency CN. FACTORS AFFECTING THE DESIGN OF TRANSPORT INTERCHANGES. Traffic Engineering and Control (United Kingdom). April 1971, v12, n12, pp. 625-627.

Results are presented of two surveys carried out in London and Wallasey. The London survey examined the effect of the introduction of a flat-rate short-distance bus service serving Wealdstone and Kenton stations in North London and the provision of a new car park close to Harrow-and-Wealdstone station. The survey was also designed to detect the change in the number of car owners traveling by rail and to determine the hinterland covered by each station. The aim of the Wallasey survey was to examine the correlation of the mode of travel used to reach the ferry with the socioeconomic characteristics of the area of origin and the distance traveled to the ferry terminal.

Klein N. BALTIMORE URBAN DESIGN CONCEPT TEAM. Highway Research Record, Highway Research Board. 68, n220, pp. 11-16.

Architects, engineers, planners, urban designers, economists, sociologists, and government experts are working together on a framework for Baltimore urban design. The process of urban highway planning focuses on three aspects to obtain a single product: the road, joint development, and urban programs. The road includes the highway in relation to the complete transportation system, taking into account rapid transit, parking, parkways, city streets, and pedestrian movement. Joint development defines multiple facilities within and adjacent to the rights-of-way for

schools, recreation, housing, and commerce, and other functions vital to urban areas. Urban programs consist of environmental programs such as relocation, employment, education, housing, and neighborhood improvement, which must be accomplished in the highway environs. The first study phase of the project consists of analyzing and researching the social needs, the neighborhood needs, transportation problems, architectural, historic, and visual problems and opportunities, economic resources and limitations, and the governmental actions in implementing the project. The second phase will consist of a more detailed development of alternative options for the road itself, whether it be below-grade, on-grade, or above-grade, and will include economic feasibility studies. The last phase will be the execution of the chosen alternative.

Ronan WJ. SHIFTING EMPHASES IN TRANSPORTATION. Highway Research Record, Highway Research Board. 67, n183, pp. 7-12.

Highway planners are aware of the shifting emphasis from the specific mode of transportation to the total function and need for an integrated transportation system. Other shifts of emphasis discussed are: (1) a recognition that transportation is basically a regional, rather than a local, problem; (2) transportation must be viewed in terms of its impact on the total well-being of the community it is intended to serve; and (3) its problems demand a new order of intergovernmental cooperation for their solution. Unless planning and research take cognizance of actual operating conditions and problems, the potential contribution that sound planning and research can make toward improved transportation will not be realized. A true partnership of the three levels of government -- state, local, and federal -- is essential for the achievement of a truly total comprehensive and regional transportation policy.

Hajj HM. RAPID COMMUTER TRANSIT FOR MEDIUM-SIZED URBAN AREAS. South Carolina University, Urban Mass Transportation Administration. January 1975, Contract No. DOT-UT-419, 318 pp.

The approach to the problem took into account present and future travel, public attitudes and preferences, available on-site facilities and state-of-the-art equipment, and the interest of local businessmen, financial agencies, and government officials in solving the problem prior to its continued development. Chapters include: an inventory of existing conditions in the corridor; models and forecasts (1995) of planning and travel data; alternative transit concepts such as priority lanes and ramp metering; detailed analyses of the most promising transit alternatives; recommendations for the provision of high quality transit service in medium-sized urban areas; and the extent of applicability of these recommendations to medium-sized urban areas throughout the United States.

Claffey PJ. USER CRITERIA FOR RAPID TRANSIT PLANNING. Journal of Urban Planning and Development Division of American Society of Civil Engineers. September 1964, v90, nUP1, Procedure Paper 4033, pp. 5-14.

Modern rapid transit systems, to serve a useful urban function, must provide a level-of-service acceptable to users; otherwise, they will fail to

attract sufficient patronage. However, a transit system planned to give every user the advantages of the automobile, in terms of privacy and convenience, as well as the freedom from driving responsibility provided by transit, would be prohibitively expensive. Thus, it is of critical importance that an objective set of standards or criteria, designating minimum levels-of-service acceptable to users, be developed for the guidance of the urban transportation planner. The aspects of transit service important to users are travel time, rider comfort, rider convenience, fares, and rider safety. Each of these factors is important to users, and each has an influence on their choice of travel mode. These influences, however, do not have an equal effect. A review of recent studies in this area indicates that travel time and travel comfort are probably most important to users, and are followed closely in importance by rider convenience. The effects of fare schedules depend, to a great extent, on user income levels; but, for peak-hour travelers, they are probably not too important. Safety is least important as a determinant of urban travel mode. At present (1964), the planning of rapid transit systems to provide for user needs is almost entirely dependent on planners' subjective judgments. More objective data on user needs for urban transportation service are necessary. Research effort of a high order must be conducted in this area.

Goldberg MA. Heaver TD. A COST-BENEFIT EVALUATION OF TRANSPORTATION CORRIDORS. Highway Research Record, Highway Research Board. 70, n305, pp. 28-40.

The transportation corridor approach to planning transportation is a mixture of three basic ideas: buying land early, buying more land than is needed for initial transportation facilities, and buying more land than will be needed for transportation alone. The land is held in a lower level of use than would otherwise develop so that transportation costs are reduced and efficient land use is promoted. The relevant costs for cost-benefit analysis are the economic costs of acquiring and holding land. The main benefits are savings in costs. Indirect and intangible costs and benefits can be expected because of the impact of transportation on land use. The nature of costs and benefits and possible methods for measurement are described in the paper. A benefit-cost model is then described by which the essential questions of how much land to buy, and when, can be evaluated. The maximum tangible net benefit from the corridor approach to transportation planning will be attained by buying land when the cost of delayed acquisition is rising more rapidly than the cost of early purchase. This simple relationship is the heart of the corridor concept./Author/

Peterson T. COST-BENEFIT ANALYSIS FOR EVALUATING TRANSPORTATION PROPOSALS: LOS ANGELES CASE STUDY. Land Economics. February 1975, pp. 72-79.

Although most economists and public officials understand the theory of cost-benefit analysis, there seems to be great difficulty when it comes to applying this technique to "real world" problems. This paper critically examines a cost-benefit study undertaken for a proposed rapid transit system in the Los Angeles metropolitan area in order to illustrate the

problems and to suggest alternative methods for treating them. For the proposed Los Angeles rapid transit system, the benefit-cost ratio is favorable (exceeds unity) only because: (1) many benefits are incorrectly calculated due to such factors as inflation, anticipated unemployment reductions and expenditure decreases, along with double counting and the inclusion of non-quantifiable benefits; (2) many costs are understated or omitted entirely; and (3) the passenger estimates are overly optimistic. This last point is particularly important since passenger estimates are crucial to a cost-benefit study of any rapid transit system./Author/

Rubin F (International Business Machines Corporation). ROUTING ALGORITHMS FOR URBAN RAPID TRANSIT. Transportation Research. August 1975, v9, n4, pp. 215-223.

A basic routing algorithm is presented for finding optimal routes for cars in a rapid transit system. The algorithm uses predicted path cost, depth-first search, and threshold acceptance to minimize computation cost. It is applicable to synchronous, cycle-synchronous, and trans-synchronous control strategies, and will minimize either departure time, transit time, or arrival time as may be needed. Extensions of the algorithm to allow finding empty cars to answer service requests, to dynamically reroute cars in the system, and to handle multistation routes are presented.

Hinkel JJ. et al. POTENTIAL IMPACTS OF RAPID TRANSIT AND PUBLIC RESPONSES TO RAPID TRANSIT PLANS. High Speed Ground Transportation Journal, Planning-Transport Association, Inc. April 1974, v8, n1, pp. 87-123.

The analysis of the rapid transit plan developed for the St. Louis region was utilized to present a procedure for analyzing costs and benefits of rapid transit impacts to users and nonusers and people's attitudes toward these impacts. An interview scaling technique was applied to various socioeconomic groups to learn their attitudes toward such transit features as subways, transit security, surface tracks, and access parks and schools. This type of analysis was oriented toward assisting the transit planner to make the choice between modifying his plan in the face of opposition or seeking to achieve a compromise between groups who oppose separate features of the proposed system. This report suggests ways in which a formula for applying political wisdom to achieving rapid transit success in large urban areas could begin to be developed.

Bruggeman JM. Worrall RD. PASSENGER TERMINAL IMPEDANCES. Highway Research Record, Highway Research Board. 70, n322, pp. 13-29, 8fig, 7tab, 6ref.

Conventional transportation network analysis requires the estimation of the times necessary to complete three portions of a typical intercity trip. Although the times associated with the line-haul and access portions have been studied extensively, the time required for transfer between access and line-haul modes has not been handled adequately. These times, or impedances, occur at any intercity passenger terminal for air, rail, and bus modes. This paper identifies each of the major components of the passenger terminal system and develops the respective impedance

methodology for each, as well as a technique for combining them into a single value representative of the total impedance level for a particular terminal. Data were collected at several intercity terminals in the Washington, D.C. area and the impedance levels were determined for each terminal. The methodology and many of the component values are directly transferable to other terminals. In addition, the methodology may be used as an aid in evaluating alternative functional arrangements of the various terminal facilities./Author/

Manheim ML. Rutter ER. DODOTRANS I: A DECISION-ORIENTED COMPUTER LANGUAGE FOR ANALYSIS OF MULTIMODE TRANSPORTATION SYSTEMS. Highway Research Record, Highway Research Board. 70, n314, pp. 135-163, 4fig, 29ref.

The major features are presented with an example of a computer language and set of programs that were developed at the Massachusetts Institute of Technology. The objectives motivating this development, one substantive and one procedural, were: (1) the system should be policy-sensitive -- that is, able to predict the consequences of a wide range of alternative policies toward multimodal transportation systems in a theoretically acceptable manner; and (2) the system should support an analysis process in which the analyst explores a wide range of alternatives and amasses large quantities of information while seeking to develop his understanding of the policy issues in a particular problem. The decision-oriented data organizer-transportation analysis system (DODOTRANS) reflects this philosophy. It is policy-sensitive in that it: analyzes multimodal transportation systems; can test a wide range of options; can predict a wide range of impacts; finds equilibrium of supply and demand in the network explicitly; and contains supply, demand, equilibrium, resource requirements, demand shift, and evaluation capabilities. The evolutionary nature of DODOTRANS is stressed. A model is described for determining a suitable level of highway investment in a large, primarily urbanized region and the allocation of this investment to subareas within the region based on the common set of social and economic considerations. The model offers the following advantages as compared to existing methods: (1) it requires a minimal amount of travel information; (2) the objective function may be modified to reflect the values of the region under study; (3) the importance of different objectives on the final proposal may be tested; (4) the objective function provides a basis for making trade-offs between the allocation of resources to high-density areas where costs and benefits are high, and low density areas where costs and benefits are low; and (5) a general level of requirements which will serve as a framework for development of more specific proposals can be established early in the planning process. The model is described in detail.

- *Land-Use/Transportation Relationships*

LINEAR CITY RAPID TRANSIT AS A DETERMINANT OF URBAN FORM. The University of Texas at Arlington, Department of Architecture. September 1970, Contract No. UMTA-TX-11-0001-73-1, 50 pp.

The purpose of this study was to forecast and describe some of the physical planning implications of implementing innovative types of public transportation in the Dallas-Fort Worth region. In this context, the

authors have sought to document in this report conclusions about some of the physical implications of the use of rapid transit to structure new forms of urban development and to depict, in words and images, impressions of the increased quality of life possible in these transit-structured communities. The study approach consisted of developing generalized concepts for structuring new urban growth based upon transit, and then particularizing these concepts by applying them to specific parts of the Dallas-Fort Worth region. The initiation of this process involved gathering an extensive inventory of physical, economic, and demographic data on the geographic area chosen as the focus of this study.

Houghton-Evans W. TOWN PLANNING AND PUBLIC TRANSPORT. Journal of Royal Town Planning Institute (United Kingdom). June 1971, v57, n6, pp. 264-267.

The history of public transport is reviewed as it has influenced the development of towns, especially in the United Kingdom. A significant turning point in town planning has been reached where a public transport system separate from other vehicular traffic is the ideal to be striven for. It must be intimately woven into the pedestrian parts of the town. All urban traffic must be brought under rigorous public control, as regards both its routing and timing./Author/

Mackey EC. ISSUES AND POLICY QUESTIONS CONFRONTING PUBLIC TRANSPORTATION. Highway Research Board Special Reports. 73, n136, pp. 105-109, 2tab, 1ref.

The need for innovation in operating practices and in the development of transportation is noted. Most proposals focus funds on rail facilities linking high income suburbs or airports with downtown centers and on new equipment. Stations are placed far apart and provide poor linkages between station and traveler origin or destination. The proposed Woodward corridor rapid rail line in Detroit is reviewed and the limited functional capability of a rail rapid system to serve suburban access as well as central city mobility is observed. The importance of the location of the potential users and the defining of benefits and costs in the application of this technology is emphasized. The issues of market demand and cost are complicated further by their relation to the transportation system design. The demand-responsive transportation project in Ann Arbor has the potential of meeting transit needs in the area as well as providing research regarding people's travel needs. The cost of such a system needs to be evaluated in relation to objectives such as air pollution, downtown traffic congestion, and parking costs.

Evans HK. BALANCED HIGHWAY-AIRPORT DESIGN. Transportation Engineering Journal, American Society of Civil Engineers. February 1969, v95, nTel, Procedure Paper 6420, pp. 213-228.

Planning for the tremendous growth of airport complexes has many similarities with city central business district (CBD) problems. The problem of peripheral land use development is discussed and time savings with various types of ground transport systems are evaluated. It is concluded that dependable rapid transit, as an adjunct to the auto, is needed. Ground traffic congestion now results in the air traveler spending from

one-third to two-thirds of his portal-to-portal trip time on the ground. Rail rapid transit has not proven successful, generally due largely to dispersed ground trip origins and destinations. Seven airport-CBD rail links are described, showing only two as attracting substantial patronage: Brussels and London Gatwick. The answer to the access problem appears to be high-speed, low-capacity ground systems, such as buses, with priority treatment on highway routes; examples are given as to how this has been achieved.

WHERE TRANSIT WORKS: URBAN DENSITIES FOR PUBLIC TRANSPORTATION. Regional Plan News. Number 99, August 1976, 23 pp.

This report summarizes a two-year study by Tri-State Regional Planning Commission examining significant transit characteristics of New York Tri-State Region. Study addresses the question of the quality of transit that can be provided within various land use patterns and density levels. Eight modes of public transportation are compared relative to cost and ridership levels among different density levels. Original report has been revised and published by Indiana University Press in 1977 under the title Public Transportation and Land Use Policy.

- *Specific Plans*

REGIONAL TRANSPORTATION PLAN. TECHNICAL SUMMARY REPORT: VOLUME I. San Diego County Comprehensive Planning Organization. Urban Mass Transportation Administration. March 1975, Contract No. UMTA-CA-09-0037, 240 pp.

The report is the technical summary of the Regional Transportation Plan for the San Diego region. It contains an overview of the plan's development process; describes the existing transportation system; summarizes the Regional Transportation Plan by modal elements; contains adopted regional development and transportation goals, objectives, policies, the implementation strategy (financial plan), proposals for changes in institutional arrangements (operations plan), and a description of the continuing planning activities to be undertaken to further refine and assist in plan implementation. NTIS PB 244 893/4ST, DOTL.

REGIONAL TRANSPORTATION PLAN. FINANCIAL PLAN: VOLUME II. San Diego County Comprehensive Planning Organization, Urban Mass Transportation Administration. March 1975, Contract No. UMTA-CA-09-0037, 99 pp.

This report documents the financial analysis undertaken in the Regional Transportation Plan. Following a brief description of the plan elements, the report describes the basic assumptions used for cost and revenue escalation and source of funds. A cost/revenue comparison for the transit and highway elements is presented and the additional transportation funding needs are identified. The final chapter discusses three financial policies adopted to support plan implementation. A five-part appendix documents the history of transportation revenues and expenditures in the San Diego region, describes the cost constrained financial plan, and contains the detailed project listings and revenue and expenditure forms required by the California Department of Transportation.

REGIONAL TRANSPORTATION PLAN. DEVELOPMENT OF THE PLAN: VOLUME III. San Diego County Comprehensive Planning Organization, Urban Mass Transportation Administration. July 1975, Contract No. UMTA-CA-09-0037, 191 pp.

The report describes the methodology used to develop the Regional Transportation Plan and documents the major elements of that methodology, including the regional goals and objectives program, the citizen participation program, the plan development alternative studies, the evaluation criteria utilized to select a development strategy, the policy selection process, and the plan refinement and staging process.

Cohen EB. et al. AN URBAN TRANSIT LABORATORY. Operations Research Society American Bulletin. 67, v15, n1, pp. B-74 -- B-75.

A plan is presented for long-range comprehensive experiments in urban transportation. The plan is based on gradual redevelopment of an existing area with minimum removal or new construction of buildings. A public transportation system would serve as a test bed for vehicle and guideway engineering experiments and for new operating concepts. The most crucial result of the experiments will be clarification of social need by analyzing public reaction. The experimental program is discussed in terms of a specific implementation in suburban Philadelphia. The land-use experiment attempts to closely integrate a transit line into a community structure. The stations are closely spaced and connected to the residences by pedestrian walks; the streets would be closed to through traffic; traffic generating centers (stores, schools, etc.) will be encouraged to locate close to the transit line; and additional services, such as package delivery, would be provided at the major stations. As a control, half the route would merely run down the median strip of an existing major street. The same right-of-way is expected to serve as test bed for a field test of a vehicle which can be mass produced for a wide range of urban transit applications. Right-of-way improvements will emphasize quiet operation, use of naturalized plantings, and safety design. Operational changes will consider handling of packages and the interaction of operator and passengers. Later experiments will operationally test new propulsion, guidance, and suspension techniques. Unmanned vehicles and continuously moving systems will be operated in the last round of engineering experiments. The experimental area includes two working class district, mostly middle class neighborhoods, and an upper middle class section. Because the area consists of discrete neighborhoods, each with an individual character and economy, it is particularly suited for observing the social effects of service variations. The innovations will include special provision for both aged and immature patrons. Other direct services will include provisions for parcels and shopping carts. Indirect services will include recreational facilities along the right-of-way, stands for newpapers and sundries, and neighborhhod police protection. The effect of planned relocation of facilities, such as schools, will be measured. The voluntary migration of traffic generators, including stores and offices, must also be observed over an extended time period. Additional experiments can be conducted in employee motivation and intergovernment/private agency coordination problems.

IMMEDIATE IMPROVEMENTS IN PUBLIC TRANSPORTATION: PORTLAND-VANCOUVER METROPOLITAN AREA. Deleuw Cather and Company. June 1973, Technical Study No. UMTA-IT-09-008-73-2, 191 pp.

This report describes the analyses, conclusions, and recommendations concerning immediate improvements in regional public transportation to be implemented in the next few years. The report describes present transit service in the area, outlines surveys and analyses performed, articulates objectives and standards, recommends a plan for transit improvements, presents estimates of financial results of operation, and outlines an implementation program. A summary of the conclusions and recommendations is included at the beginning of the report. Part II, which is not yet finished, will be the 1990 PUBLIC TRANSPORTATION MASTER PLAN. The implementation of the plans presented in both parts will result in a regionwide bus rapid transit system operating on exclusive busways, reserved busways on existing streets or in mixed traffic, with the capability to be converted to a new technology of public transportation systems as that technology unfolds. The performing organization worked closely with the staffs of the Columbia Regional Association of Governments (CRAG), the Tri-County Metropolitan Transportation District (TRI-MET), the City of Portland, the Oregon State Highway Division, and staff members of the various cities and public agencies throughout the metropolitan area. Meetings with civic, professional, and community groups were held to inform the public and to receive comments on the plan. Two large maps, one on existing transit service as of 1971 and one on the recommended transit plan, are included.

PROPOSED TRANSPORTATION MASTER PLAN FOR DADE COUNTY -- A SUMMARY. Metropolitan Dade County Planning Department. February 1969, Project No. Fla-t9-1.

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. 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. 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 percent increase in transit ridership before 1985. Specific corridors to be served were also identified by projections of area demography and trip generation. Routes and special service for airport access are proposed, and continued investigation on dual-mode buses and other innovative transit systems is recommended. Airline passenger volume is expected to increase by nearly 500 percent 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 multimodal 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 PB 184 764.

NIAGARA FRONTIER MASS TRANSIT STUDY -- SUMMARY REPORT. Niagara Frontier Transportation Authority. September 1971, Project No. Ny-t9-4.

The study was conducted in four phases: (1) collection and evaluation of data; (2) selection of vehicle and guideway systems; (3) testing of alternative alignments and system configurations; and (4) determination of technical and economic feasibility. Phase 1 activities included an inventory of the 11 regional bus companies, a modal-split analysis of existing ridership, an attitude survey of area households, travel time checks, 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 rates. In addition, the report estimates a likely regional highway network for 1975. All of this information served as input to a computer program that generated 23 alternative segmental links for the proposed rapid transit line. These were evaluated for their impact on seven urban design factors and seven service quality features. The analysis yielded three alignments which were then tested against 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: minimum service parameters, peak-hour capacities of 20,000 passengers, fail-safe automatic controls, cost, and feasibility within state-of-the-art. Eight specific systems were selected for further analysis. It is concluded 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 PB 208 524.

Smiglielski WK. CITY PLAN SAYS NO TO THE MOTOR CAR. Zeitschrift Verkehrssichereit (Germany). 66, v12, n4, pp. 241-245.

A new technique used by the industrial and university center of Leicester, England with a view to a comprehensive modernization of the city could be described as a revoluation in town planning comparable in its importance with the Garden City movement. The actual planning work was done by a

computer which evaluated a mass of data such as travel habits, land use, and economic and social factors. The result was a plan based on the circumstances estimated to prevail in the city after a 30-year period. The key to the plan is an integrated transport system which provides for interchange car parks at peripheral areas while inner Leicester, with its historic buildings, is to be reserved for special public transport and for pedestrians./Author/

Kizzia T. LOS ANGELES: WILL TRACKS BE BACK? Railway Age. June 1974, v175, n11, pp. 30-41.

The Los Angeles region of California is heavily reliant on automobiles. This article discusses the battles that have been going on to create a rapid transit system for the area. A delicate balance must be struck; a rapid transit system plan has to be extensive enough to be politically popular but not large enough to scare away federal support. The discussion also touches on jurisdictional problems, as there are 78 cities within the county that must all cooperate in some kind of a system. The benefit cost analysis of rail versus bus transit and the advocates of each in the federal agencies and industry are crucial parts of the decision-making process. The one point of agreement is that Los Angeles has a severe transportation problem and that something must be done about it.

RESEARCH AND NEW TECHNOLOGY

- *Research and Development*

Hill FN. TRANSIT INDUSTRY RESEARCH NEEDS. Highway Research Board Special Reports. 73, n137, pp. 11-17.

Transit's potential and limitations in relieving the consequences of traffic population growth in San Antonio are discussed. If the bus ratio in automobile traffic is increased, a significant reduction in peak-hour traffic may be achieved. Comprehensive studies for a modernization program with the objective of attracting new ridership is in progress. The program, calling for an expenditure of $7,441,200, will include construction of new buildings, acquisition of equipment, and installation of passenger shelters. Guidelines for the program were provided by analysis of findings from a questionnaire survey and interviews. The research project considered express service, reverse commuting, three categories of cross-town service, park-and-ride facilities at strategic points, and the need for public awareness of transit service. Preferential treatment for buses such as reserved downtown lanes and streets, electronic controls which favor bus movement, the metering of urban freeways to aid free-flowing traffic, and the construction of special busways within freeways, would all improve bus operation. Financing for the improvements could be provided by the Urban Mass Transportation Act (1970) and the Federal-Aid Highway Act (1970), supplemented by state and municipal funds. Transit industry management officials will bear the responsibility for leadership in the development of the many new opportunities.

Krambles G. TRANSPORTATION RESEARCH IN CHICAGO. Highway Research Board Special Reports. 73, n137, pp. 4-7.

Planning areas related to service, marketing, operation, and capital investment of the Chicago Transit Authority (CTA) and important areas of need in research and development are discussed. Modernizations such as the operation of a radio station for two-way communication, the use of an automatic train dispatching system in line supervision technology, expansion of the system of communication and operation supervision, the extension of the rapid transit system, the use of buses to complement the latter system, and the development of a unique service to a suburban industrial location are discussed. The bus-monitor system is a development in the field of speed and dependability. Right-of-way and reserved lane techniques for buses need development and testing. Funding and public acceptance aspects of marketing, bus design, rapid transit car equipment, public information marketing, and ways of quantifying trade-offs of route changes need developmental investigation. The potential in the use of psychological and visual-audio communication and the experience of CTA in this field are described. There is a need for services to communities in light density areas. Models for traffic estimation need to be developed and revenue handling in buses must be modernized. Fare policy is indicated as a field for research as is also capital investment, planning, and programming. The extent of the CTA budget expended on research and development is given and the necessity for governmental aid programs is emphasized.

Alexander DE. SEATTLE MONORAIL DEMONSTRATION STUDY. Washington University (Seattle). October 1962, Project No. Wash-mtd-1.

A comprehensive appraisal of the effectiveness of the monorail as a metropolitan rapid transit facility was made by collecting and analyzing factual data from six months of operation during the Seattle World's Fair. Mechanical and structural characteristics were determined through observation, consultation, and measurement. 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 contains: 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 chamber, 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 other transit facilities. NTIS PB 174 423.

Marks NG. DESIGN OF EXPERIMENTAL AERIAL TRANSIT STRUCTURE. American Society of Civil Engineering Journal, Structural Division. October 1967, v93, nST5, Procedure Paper 5519, pp. 323-342.

The experimental mass transit expressway developed, constructed, tested, and evaluated in South Park near Pittsburgh, Pennsylvania is part of a new concept for much-needed urban mass transportation. The test track supported on steel stringers and columns is 9360 feet long and requires approximately 2300 tons of ASTM A36 steel. The stringers were designed and fabricated to follow the many horizontal and vertical curves, grades, and superelevations purposely built into the system. The structure forms a test loop and carries electrically powered, computer controlled, lightweight transit cars which may operate through a given point at two-minute intervals. The cars are automatically steered by a continuous steel I-beam located midway between the two track stringers. The steel structure is supported at each column on single five-foot or six-foot diameter reinforced concrete caissons drilled at least 10 feet into rock. An electronic computer was used in the development of the geometry and structural designs./Author/

Harmelink MD. Armstrong MD. NEW DEVELOPMENTS IN MASS TRANSIT TECHNOLOGY. Roads and Transportation Association (Canada). September 1971, 43 pp.

This paper begins with a discussion of technical improvements and innovations in the use of buses and other conventional vehicle modes. Among these are exclusive bus lanes, exclusive busways, articulated buses, buses fitted with rail wheels, the bimodal bus, and dial-a-bus systems. The potential advantages are flexibility of operation, increased capacity,

improved off-peak service, lower levels of noise and air pollution, reduced capital and operating costs through the use of innovative technology -- air cushion suspension, magnetic suspension, and linear induction motors. Selected examples of vehicles used in intercity systems, high-capacity short-distance urban systems, and intermediate-capacity systems are illustrated.

Goehler GF. MASS TRANSPORTATION: FUTURE RESEARCH NEEDS. Highway Research Record, Highway Research Board. 70, n318, pp. 12-15.

Los Angeles has proposed to the Urban Mass Transportation Administration the funding of an exclusive grade-separated busway that is expected to provide 6000 seats an hour during peak traffic. A number of problems in bus and other rapid transit modes need resolution before rush hours become less congested and time-consuming. Among these are mode interface and competition analysis, improved and people-oriented movement through the CBD, bus design, better utilization of existing rights-of-way, marketing analyses aimed at determining the kinds of transit services that would attract new riders, vehicle location systems for headway control, better and more rapid passenger information services, and compilation of more useful statistical data.

- *Concepts for Fixed-Way Systems*

Levinson HS. PEOPLE MOVERS: PLANNING AND POTENTIALS. Highway Research Record, Highway Research Board. 72, n397, pp. 1-11, 5fig, 3tab, 4ref.

An overview of people movers is accompanied by cursory analyses of planning guidelines, market potential, and means of integrating people movers into the overall transportation system. Given the characteristics of pedestrians in downtown areas -- particularly their reluctance to walk more than 100-1500 feet and the tendency for the highest volumes to concentrate in a few blocks of the downtown core -- microsystems should be designed for short-distance, high-volume conditions. System length will be less than three to four miles, and passenger rides will be less than a mile. Average waiting times should not exceed two to three minutes, which implies headways of one to two minutes during peak periods. From assumptions made about a 30-passenger bus versus a microsystem, comparisons are made regarding costs and patronage. More than 125 candidate microsystem technologies have been proposed, of which a few either have special promise or are undergoing application now, generally at airports.

DASHAVEYOR TRANSIT AND CARGO SYSTEMS: A BASELINE DEFINITION. Dashaveyor Company. May 1970, Project No. Trd-43.

The Dashaveyor transit system, although developed initially to satisfy unusual requirements in the field of bulk materials handling, can incorporate modifications to permit the transporting of people, containerized freight and supplies, or mail in an urban situation. 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 design, propulsion units, vehicle configurations, and automatic control functions.

Flexibility in the design of all components permits 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, United States of America. Separate analyses of the Dashaveyor configuration are provided for its different applications. As passenger transportation, the system is designed primarily for intracity operation, particularly as a feeder system for larger-capacity corridor operations. 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, a particular advantage 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 intraurban movement of baggage, freight, and mail by Dashaveyor. 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 PB 192 734, HRIS 84 214431.

Wilson DG. PALLET SYSTEMS FOR INTEGRATING URBAN TRANSPORTATION. American Society of Civil Engineers Journal of Transportation Engineering. May 1972, v98, nTe2, Procedure Paper n8900, pp. 225-242.

Transportation systems under development are broadly divided into train-type systems, in which vehicles stop at mainline stations, and flow systems, in which all speed changing and stopping are carried out on branch lines. Choices made for suspension, propulsion, control, switching, guidance, power, and braking, are reviewed and the palleted automatic transportation (PAT) system being developed at MIT using synchronous propulsion and control is described./Author/

SKY-KAR TRANSIVATOR SYSTEM: A BASELINE DEFINITION. Sky-Kar Corporation. May 1970, Project No. Trd-43.

The system, a short-haul horizontal people mover, is composed of three basic components. The vehicles, referred to as kars, are designed 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 superstructures. The controls, that segment of the system which performs the automation functions, incorporate the most modern technical information. 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 12 passengers (six seated and six standing); no provisions are made for baggage. Studies of automatic elevators with similar capacities show an average of eight seconds unloading time and 10 seconds loading time; preliminary plans for sky-kar are based on times of 15 seconds for both loading and 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 PB 192 727, NRIS 84 214427.

GENERAL ELECTRIC AERIAL TRANSPORT SYSTEM: A BASELINE DEFINITION. General Electric Company, Erie Transit Systems Department. May 1970, Project No. Trd-43.

The General Electric Aerial Transport System (GEATS) utilizes a unique suspension concept in which vehicles are connected to rubber-tired, electrically powered trucks running within an enclosed beam-way structure. The GEATS is essentially a modification of the safege system in France. The report documents extensive testing of the safege concept with reference to safety, vehicle stability, and ride quality. Several advantages of the GEATS design are highlighted: (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. System performance is evaluated with regard to station, 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. Potential adaptations of the baseline system for high-speed and small-vehicle applications are examined. A GEATS powered by linear induction motors to achieve higher speeds is suggested. The GEATS would be particularly effective when adapted to move small vehicles (less than 10,000 passengers per hour capacity) over short distances within a dense urban area. NTIS PB 192 732, HRIS 84 214425.

Camp S. CAB TRACK SOLVES THE CRISES WITHIN PUBLIC TRANSPORT. Teknisk Tidscrift (Sweden). 72, v102, n6, pp. 14-16, 19-20, 5fig, 1tab, 5ref, 3phot.

Cab track is a new form of urban transport which would help to reduce the number of private cars in towns and eliminate the need for underground trains. The cab track system consists of a number of driverless cars which go directly from terminus to terminus. Many different systems are being developed throughout the world. Most of them use some variation in the "synchronous slot" system, in which the cabs are controlled by electric impulses which keep them at a given distance from each other. Each cab takes two to four passengers. In order to compete with passenger cars, the cab track must be comfortable and fast. A large proportion of the goods distributed within a city could be sent in containers fixed on the cabs. Investigations have shown that the number of passengers using public vehicles will increase from 13 to 38 percent if the cab track system is fully developed. At present, it is estimated that about 50 American cities are investigating the cab track system. Two systems will be contracted shortly. In Gothenburg, a cab track system could be built for half the cost of a corresponding underground railway.

GUIDED BUS SYSTEM STUDIED IN BRITAIN. Passenger Transport, American Transit Association. September 1967, v25, n21, p. 7.

A guided bus system is being studied. It involves an ordinary bus that runs under normal driver control until it reaches the congested center of the city, at which time it moves on specially reserved track on the surface or overhead. An electrical cable underneath the road surface or similar devices keep the middle of the bus within a foot or two of the middle of the lane, and the driver is instructed when to accelerate or slow down. In this way, lane widths can be narrower than in streets carrying mixed traffic, and bus speeds of up to 50 and 55 mph maximum and averaging 30 mph may be feasible. Bus design and operation, economic potential, control gear, signaling system, and the track are being investigated. The problem is to devise a system for controlling the distance between vehicles in mixed traffic and to warn of pedestrians or animals straying into the road.

Avery WH. AN INTEGRATED URBAN-INTERURBAN TRANSPORTATION CONCEPT. Johns Hopkins University, Applied Physics Laboratory. December 1967, 32 pp.

Public transportation systems for a city should combine an urban system for trips not exceeding 10 miles with a high-speed, high-capacity system for longer trips. These systems must be designed to prevent or alleviate problems of pollution and congestion on city streets. The principal requirements for a new system are convenience, low transit time, reasonable cost, feasibility with current technology, all-weather operation, and social desirability. For trips not exceeding 10 miles, an aerial car transportation (ACT) system is proposed. The system is based on a series of small cars traveling at an average speed (including time for boarding) of 10 mph on a single enclosed elevated rail, pulled by an electrically powered cable. For commuter trips exceeding 10 miles and for intercity travel, a high-speed, high-capacity system is required. The gravity vacuum system which, when combined with ACTS, would provide a comprehensive public transportation system for an area. These studies show that the combination of the aerial car transit system for local travel and a high-speed transit system for longer distances offers the possibility

of economical urban transit that will be attractive to future travelers and will, therefore, be able to operate with a profit, while alleviating many of the present problems resulting from current practices./Author/

- *Dual-Mode and Automated Highways*

Weinberg MI. THE URBMOBILE -- A DUAL-MODE VEHICLE SYSTEM DESIGN CONCEPT. Society of Automotive Engineers. May 1968, Paper 68397.

A new type of transportation system is defined and described. It is primarily intended for use in metropolitan areas where the land use is so deployed that the automobile is the dominant form of transportation. It is expected to alleviate the growing problem of traffic and parking congestion in the central business district of such cities and to reduce air pollution. The system uses a dual-mode vehicle, one that can operate on streets and highways in the manner of a conventional automobile. Also, it can enter an exclusive guideway (railroad) at discrete access points and be routed and propelled automatically to a destination station. For operation on the street, this electrically propelled vehicle draws its power from an internally stored energy source (storage battery). When on the guideway, the car takes its power from a "third rail." The basic vehicle is a small, four-passenger machine, but the system can accommodate a small bus (10-14 passengers) and a light delivery truck. In the guided mode, the three-phase induction motor runs at near-synchronous speeds and, thus, all cars travel at approximately the same speed, obviating the need for complicated headway control. Extreme attention to safety by means of simplification and use of conventional reliable components is important./Author/

Stefanek RG. Wilkie DF. CONTROL ASPECTS OF A DUAL-MODE TRANSPORTATION SYSTEM. Institute of Electrical and Electronics Engineers, Transactions on Vehicular Techniques. February 1973, vVt-22, n1, pp. 7-13.

Control problems associated with the operation of a network of automatically controlled, closely spaced, high-speed vehicles are considered. A system-operating concept based on the synchronous moving-cell approach to individual vehicle control is presented. The need for a network traffic management strategy, called cycle preprogramming, is discussed. Finally, a study of the efficiency of the cycle preprogramming traffic management strategy is described./Author/

Canty ET. METRO GUIDEWAY: AN INTEGRATED URBAN TRANSPORTATION SYSTEM. Highway Research Record, Highway Research Board. 72, n397, pp. 26-37, 4fig, 28ref.

The greatest need of future urban transportation is for improved arterial transportation facilities in larger metropolitan areas. To provide for these needs by conventional means, including additional urban freeways, expressways, arterial streets, and public rapid transit systems, will entail the expenditure of large sums of money and will create social and environmental impacts that will limit the public acceptability of the new facilities. It may be possible to reduce such economic and social costs through the development and implementation of new arterial systems. An

integrated urban transportation system called the metro guideway is described. This would provide an automated roadway network accommodating dual-mode automobiles, personal and group rapid transit vehicles, and automated freight carriers. A brief resume is given of the current program of design, analysis, and evaluation of the metro guideway concept. /Author/

Haikalis G. SUPRA-CAR. Tri-State Transportation Commission. Presented at meeting of the Highway Research Board. January 1968.

Pneumatic-tired, individually steered, self-propelled vehicles have been the backbone of the nation's passenger transportation system for over 50 years. Every expectation is that this dominant role will continue for many years into the future. The concept and design of a successor to the automobile has remained elusive. Innovation seems to be aimed at incremental improvements to the auto, or mass transit devices that are intended to divert auto travelers to transit. Outlined herein is a design for a total successor to the automobile. Auto driving would be confined to remote rural areas and race tracks and, in miniature form, at carnivals and amusement parks. Nearly all truck movements would also be accommodated by the "System," as would all mass transit travel other than longer-distance air travel.

Vathke OW. AUTOMATED HIGHWAYS. Society of Automotive Engineers Journal of Automotive Engineering. January 1972, v80, n1, pp. 20-37.

Traffic management strategy and configurations of automated highway systems are discussed. A methodology is developed to study the efficiency of the cycle preprogramming strategy in managing traffic in a large network. The methodology is then used to analyze the operating conditions on an automated network example for the Detroit area. Some transportation services, transportation facilities, and technological design choices are described for a new urban transportation system concept, the metro guideway./Author/

Bendixson T. INSTEAD OF CARS. Limited Textbook. 74, 256 pp.

The book deals with the future of transport and has two central themes: the need for revolutionizing ideas on moving people and goods and the conclusion that there is no single panacea. The author examines a number of new technologies such as driverless vehicles, electronic guidance systems, and moving pavements, and discusses ways in which they can be put to use and their limitations. New ways of using existing vehicles -- trains, buses, taxis, bicycles, and cars -- are also considered, together with new concepts of town planning and life-style that could reduce the need to travel.

Roberts J. AN AUTO-TAXI SYSTEM. Official Architecture and Planning (United Kingdom). 69, v32, n2, pp. 173-176.

The introduction of an auto-taxi network into a major urban renewal project is explored. It is proposed that electrically-powered auto-taxis running on tracks in transparent tubes be used for local journeys of

under five miles as an alternative to private cars. The four-seater auto-taxi has plenty of storage space for parcels, and with seats removed becomes an urban delivery vehicle, which could operate at off-peak periods from a central goods handling depot. Tables show capital and running costs of an auto-taxi network in an area of 60,000 inhabitants. Comparisons indicate that, per passenger-mile, auto-taxis are substantially cheaper than private motor cars, and compare favorably with buses./Author/

TRACK-SHARING FOR URBAN TRANSPORTATION. Institute of Public Administration. January 1970, Project No. NY-MTD-13.

The potential use of railway tracks is discussed for passenger movements to the center city. Examination is made of the implications of instituting such service, either by dual-mode railbus or by conventional rail equipment. The substantial vehicle development in railbuses is also reviewed. A simple inexpensive railing system, adaptable to any standard bus without major modification of the vehicle, can be installed in the shop of the bus company. The railbus concept is drawing increased attention from both national and international transportation planners. NTIS PB 192 784, HRIS 84 210864.

Wilson DG. QUADRAMODE TRANSPORT: A CLASS OF CONTROLLED SYSTEMS. Urban Engineering and Transportation. 69, pp. 88-100.

The overall design and some of the details of the operation and regulation of a class of controlled urban transport systems are described, with special reference to a palleted automated transport system (PAT). The all-inclusive benefit-cost ratio makes it a proposition deserving development and trial with other presently advanced alternatives. Four modes are logical members of the class of systems examined and account for the designation quadramode: individually owner vehicles under driven control; individually owned vehicles under automatic control; publicly or commercially owner vehicles which can take fare-paying passengers under automatic control; and means which will move unattended freight from one point on the guideway to another./Author/

- *Suburban and Intercity*

Harris GL. Seemann GR. THE TERRAFOIL: A NEW CONCEPT IN HIGH SPEED GROUND TRANSPORTATION. High Speed Ground Transportation Journal. May 1970, v4, n2, pp. 197-209.

A new concept in HSGT called the terrafoil is presented and discussed. Terrafoil is used to describe any surface-guided lifting element which generates a sustaining force by virtue of its forward motion and interaction with its guideway. A terrafoil vehicle (TV) is a vehicle sustained, guided, and controlled exclusively through the aerodynamic interaction of its terrafoils with the guideway. The potential performance of this vehicle concept is discussed only from a semi-quantitative point of view, and conclusions are drawn on the basis of preliminary experiments and elementary analysis. The paper is intended only as a concept exposition, and no claim to rigor in the discussions is made. Indeed, because of the

exceedingly limited information currently available regarding the characteristics of terrafoil vehicles and their components, a rational quantitative analysis would be difficult, if not impossible, to perform at the present time. Various types of propulsion systems for HSGT systems in general and terrafoil vehicles in particular are also discussed briefly./Author/

Zworykin VK. A SYSTEM FOR HIGH-SPEED URBAN AND SUBURBAN MASS TRANSPORTATION. Highway Research Record, Highway Research Board. 68, n251, pp. 41-46.

A mass transportation system suitable for urban and interurban traffic is outlined; the system increases the carrying capacity and minimizes crowding and waiting periods. In its ultimate form, the system utilizes individual air-cushioned cars with a capacity of about 25 passengers. These cars take on and discharge passengers at the periphery of continuously rotating platforms without coming to a stop. Transfers between local cars and express cars, similarly, can be effected without speed reduction of the express cars. Car storage is provided at the several stations, permitting rapid response of the rolling stock on the tracks to passenger demand. Propulsion may be effected by linear motors with the rotor embedded in the track, or similar techniques which minimize the weight and complexity of construction of the cars. It is a special feature of the system that the cars remain continuously in motion except when in storage. Furthermore, the passengers, in proceeding from the stationary center of the rotating station platforms to the periphery, where they mount the cars, are automatically accelerated to the speed of the cars, so that transfer is effected to and from relatively stationary cars. The system described appears well adapted to automation, economical in power consumption, and can be introduced stepwise, initially utilizing conventional cars. A close examination of technical and economic problems, with the aid of a reduced-scale model of the system and computer simulation of the system operation, is recommended.

Bauladon G. TRANSPORT. Science Journal (United Kingdom). October 1967, v3, n10, pp. 93-99.

A literature survey suggests transport systems could change radically by the end of the century, with belt transporters for short distances, 800 km/h tubes for medium distances and mach 10 aircraft for long distances. But, the most important innovation may be government legislation forcing transport systems into harmony with their environment. As soon as traffic levels justify, a whole category of assisted pedestrian systems will be put into use, even for shorter distances. For big cities, there might be the continuous underground train. This new system will be noiseless, automatic, and nonstop. Most ground level traffic will, however, be represented by small electric cars, cubic in shape. They will be propelled by high speed electric motors running at 35,000 rev/minute using alternating current without brushes or commutators. The car will remain the only means of transport available at one's home. The increase in numbers will have been so phenomenal that it will have become necessary to regulate its use, first in towns in the early 1980's and then on all motorways (by 1985) which will become electronically controlled. The main

competitor of road freight transport will not be the train, but vehicles totally enclosed within a tightly fitting "tube." Railway speed will have practically doubled in 10 years. Mechanical improvements will make it possible to gradually increase train speed to 400 km/h by about 1985. Ships will be divided into two types. There will be the almost conventional giant transporters for low value goods (ores, petrol, and grain). They will be operated by nuclear energy. Goods of higher value will be transported by container ships, completely different from those of today. These will be extremely rapid air-cushion vehicles. The hypersonic 650 passenger plane, flying at mach 6 and propelled by SCRANJET (Supersonic Combustion Ramjet), the study of which has already begun, will be available about 1985./Author/

Ross HR. NEW TRANSPORTATION TECHNOLOGY. International Science and Technology. November 1966, n59, pp. 26-37.

New developments in transportation technology are aimed at high-speed intercity travel; the danger is that Megapolitan Systems will be unbalanced by the obsolescent technology of more local transport. The trade-offs in cost, power, complexity, and space requirements vary with the degrees of freedom of vehicle movement. Tracked air-cushion vehicles show promise of faster speeds than on wheels; costs of air levitation are getting less. Linear induction motors for propulsion may lead to lighter vehicles and simpler power pickoff. In combination, these lightweight developments may make possible a revival of the elevated right-of-way with major economies. Small automatic automobile-like vehicles may provide individual modes of transport. However, circulation needs in the central business districts do not seem to be filled by any existing technology.

Mouritzen G. OPTIMIZED RAPID TRANSPORTATION CONCEPTS. High Speed Ground Transportation Journal. May 1969, v3, n2, pp. 276-284.

The possibility of developing an entirely new transportation system to fill in the requirements for rapid transit on distances too short to be satisfied by partial use of jet aircraft is analyzed on the basis of using existing technology and combining advantageous characteristics of existing vehicles. The use of existing passenger facilities and roadways was also considered in this evaluation. An optimization study was made of pertinent operating parameters such as propulsive efficiency of power plants used, power requirements to overcome total induced drag or thrust ratio, aerodynamic parameters, and best methods of obtaining desired lift. On this basis, it is shown how to select the best propulsion and lift devices for any given operating conditions. Finally, new types of transportation systems are evaluated and some feasible concepts are discussed in detail.

Pilz B. COST AND BENEFITS OF A GERMAN INTERCITY HIGH SPEED RAIL TRANSPORT SYSTEM. Battelle Information. April 1974, n18, pp. 40-42.

It is argued that the problems of applying cost-benefit analysis to transport investments can be overcome by considering separately for operators, users, and the public the costs and benefits which can then be summed and compared. Some of the factors relevant for each of these groups are discussed. High speed rail transport is proposed in Germany as a means of

increasing capacity and as a source of profits for the federal railways. Figures are given for the capital expenditure required to modernize and extend existing track and for predicted savings in journey times. It is concluded that expenditure would be justified if it reduced operating costs and produced an equivalent benefit to long distance passengers in terms of time savings, and if these conditions will be satisfied.

Richards PL. Tinkham M. MAGNETIC SUSPENSION AND PROPULSION SYSTEMS FOR HIGH-SPEED TRANSPORTATION. Journal of Applied Physics. June 1972, v43, n6, pp. 2680-2691.

High-speed transportation vehicles (trains) carrying superconducting magnets can be levitated by repulsion from diamagnetic currents induced in a conducting track. Various approximate methods are presented for calculating the lift and drag forces for such magnetic suspensions. Fourier analysis of periodic train magnet fields is used to analyze "image-force" and "hybrid null-flux" systems that involve homogeneous conducting sheet tracks. A lumped circuit analysis is used to discuss the "null-flux" principle and related systems with structured tracks. The stability and efficiency of linear induction and linear synchronous motor propulsion systems are studied using related methods.

Wormley DN. Garg DP. Boghani AB. NONLINEAR AND FINITE PAD LENGTH PERFORMANCE OF VEHICLE AIR CUSHION SUSPENSIONS. Massachusetts Institute of Technology. February 1972, Final Report, Contract No. 0 DOT-fr-10007, 130 pp.

Nonlinear and small perturbation linear models for the one-dimensional heave motion of a basic flexible-skirted air cushion suspension are formulated. A study of linear and nonlinear model characteristics under transient guideway and external force inputs is conducted to determine over what range of cushion configurations, operating conditions, and input disturbance levels a linear model provides a good approximation to the nonlinear cushion model. The performance of a finite pad length suspension on a guideway containing random irregularities is determined. To illustrate the design information resulting from the transient performance and finite length study, the prototype designs of suspensions for intraurban and intercity vehicles are discussed. NTIS PB 212 705.

HIGHBALLING ON AIR: HIGH SPEED TRAIN WILL RIDE ON A PNEUMATIC CUSHION. Compressed Air. March 1966, v71, n3, pp. 14-15.

Best future solution for short- or medium-distance transportation is an objective expert's evaluation of the streamlined aerotrain which, supported by a cushion of air on a raised, prestressed concrete track and driven by a rear propeller, will carry passengers in comfort and security at 122 to 244 mph. The transport looks like the fuselage of an airliner. Its track is in the form of an upturned tee section, the vertical projection serving as a directional guiding system. Developed in France by Bertin and Compagnie of Plaisir, the aerotrain has been given a strong boost toward early commercial application by the French government. Last spring, an interministerial meeting approved a substantial investment in construction and testing of a prototype on a five-mile stretch of single-

rail track near Versailles. Tests proved successful last month. Cost of an 80-seat aerotrain produced in small numbers is estimated at not more than $300,000 to $400,000, or from $500,000 to $600,000 for a 180-seat vehicle. Cost of support structure is calculated at $200,000 for about 1/2 mile or, with double operating lines, $400,000. If the route of the aerotrain can be placed directly along the land without being raised on pillars, the cost would be less./Author/

HIGH SPEED GROUND TRANSPORTATION AIRPORT ACCESS ROUTE STUDY, LOS ANGELES INTERNATIONAL AIRPORT TO SAN FERNANDO VALLEY. Kaiser Engineers. September 1970, Project No. Cal-t9-10.

This 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 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. Several alternating-current and direct-current electrification options were reviewed to determine the optimal system for TACV propulsion. A 1500 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. A route analysis which indicates gradient and location for each segment of the proposed system are contained, and preliminary design criteria are developed. NTIS PB 197 953.

MISCELLANEOUS

- *General*

Gaul DQ. IS RAPID RAIL TRANSIT RIGHT FOR MEDIUM-SIZED AMERICAN CITIES? Metropolitan. July 1968, v64, n4, pp. 11-17.

Recognizing the need for rapid transit as a grade-separated, private right-of-way form of urban transportation, the next step is undertaking a program for determining the mass transportation needs of the metropolitan area. Rapid transit, as we know it today, is established in many cities of the United States and Canada. The traditional steel-wheel, steel-rail principle is employed for all existing systems except one. However, in recent years other forms of rapid transit have been proposed. For example, the new Montreal subway system, opened in 1966, uses conventional subway cars except that they are equipped with rubber tires. In some quarters, the monorail has been suggested as the solution to all of our rapid transit problems. Various proposals using small cars have been suggested as a substitute for the more conventional forms of rapid transit. These proposals would include Teletrans, Starr Car, and similar systems. Many transit engineers have been searching for a less expensive form of rapid transit for medium-density operations. The transit expressway has been developed by one of the leading suppliers to our industry in an attempt to meet this concept. Still another rapid transit proposal would be the use of buses operating over surface streets in the outlying areas and making use of a grade-separated private right-of-way in congested areas. These private rights-of-way have been proposed for the median strip of expressways or along abandoned railroad rights-of-way. A variation of the bus-rapid transit proposal is the use of a bus which could operate both in normal street operation and over a conventional railroad track. The type of vehicle to be used on a rapid transit system is purely an engineering and operational question. Decisions of this type must be made on the basis of a thorough analysis of the present and future transportation demands. The article concludes with a discussion of systems either already operating or planned in a number of medium-sized American cities./Author/

Prytula G. FIXED-RAIL RAPID TRANSIT IS HEADED FOR THE CAMPUS. College and University Business. December 1970, v49, n6, pp. 45-50.

Alternatives to automobiles on college campuses may be more than an administrator's unattainable dream if current research is taken seriously. From automated fixed-rail systems to computer-controlled buses, industry is doing its share in the race for space. None of the systems is operative on a college campus, but each could be. The technology exists, and the need is more than apparent. The characteristics, benefits, design, operation, implementation costs, and financing of a fixed-rail campus transit system (CTS) are reviewed./Author/

Walbrecker R. TRANSIT MARKETING: DO'S AND DONT'S FOR A SUCCESSFUL PROGRAM. Metropolitan. January 1975, v71, n1, pp. 9-12.

Marketing in the transit industry has two main goals: (1) increased

patronage and (2) public support for transit service. Management is a most important factor to consider in a marketing program seeking to promote transit. Public information procedures, such as news media and customer information services, can be most effective in encouraging patronage. In regard to promoting transit's image, an eye-catching logo and color scheme for the vehicle is an effective device. Transit stops should be more clearly marked, and the provision of benches and shelters is a convincing aspect of the claim of providing better service. Color-coded maps of the system and telephone inquiry answering services are other indications of improved service. Community participation should be encouraged to obtain public reaction and possible suggestions for further improvement. A concern often ignored is that of driver courtesy. A training program for drivers should be provided so that all the other improvements will not appear worthless because of an inconsiderate driver. One of the most innovative marketing features is the use of promotional programs to increase ridership and keep the system in the news. These include ride home free, special family fare, ride all day. low fare special, park-and-ride, bus decoration, special passes, charter service, and bus lanes. Transit marketing techniques are being reviewed and updated constantly, and many ideas are borrowed from consumer product marketing. Only experimentation will tell what is most effective. In any case, transit systems are on the rise today as a result of both ecological and energy concerns.

Pratt RH. IMPACT OF RAIL TRANSIT ON BUS OPERATIONS. American Society of Civil Engineers Journal of Transportation Engineering. February 1971, v97, nTF1, Procedure Paper 7881, pp. 31-42.

Predictable transit passenger selection of the most desirable travel route dictates that extensive diversion of riders from existing bus operations to new rail systems planning of coordinated service is necessary to gain full benefit of new rail systems and to maintain healthy bus operations. An example of new rail service instituted without coordination shows marked loss of riders from parallel bus routes, accompanied by depressed rail line ridership and excess demand for station parking. Examples of planned coordination demonstrate that passenger use of feeder bus services can partially compensate for through bus riding losses. Planning techniques now coming into use and adherence to objectives and guidelines will allow improved design of coordinated systems. Innovative bus operation may be possible. A well designed joint operation can vastly improve urban transit service.

CARPOOLS AND BUSES. Highway User Federal Safety and Mobility. 10 pp., 1tab, 7phot.

The advantages of carpools and buses have been recognized for a long time, but some incentive has been needed to entice riders. The per person cost of commuting by various modes was considered. Findings show that the economic cost of a 10-mile trip downtown to work in a single occupant automobile is $2.64. In comparison, the economic cost of the same trip in a four-person carpool is only 66 cents per person. Economic costs include not only the cost of running the car, but also parking fees, maintenance of highways, insurance, and such expenses. To encourage the

use of carpools and bus pools, many governmental agencies and large companies are attempting to: (1) coordinate the formation of share-a-ride groups; (2) grant preferred parking spaces to those who carpool; (3) increase the use of buses by improving service and providing express bus lanes. Vans are also being used, somewhat as small buses; these provide door-to-door service. The general consensus is that, both ecologically and economically, it makes sense to consolidate.

WHY NOT CARPOOLING? EXXON USA. 73, v12, n3, pp. 24-27.

The article contains the responses of Dr. Richard I. Evans, Professor of Psychology at the University of Houston, to questions concerning carpooling. Evans feels that society has extolled the virtue of car ownership to such an extent that carpooling is difficult to operationalize. Objections included: smokers versus nonsmokers, talkers versus nontalkers, etc. On the other hand, carpools may have some therapeutic value psychologically. He feels that the majority of factors are adverse at present. The following ways are suggested to reinforce carpooling as a positive behavior pattern: (1) psychological gratification -- letters of commendation or lapel pins; (2) discounts on fuel or tires; (3) free parking; (4) priority lanes; and (5) insurance discounts. Evans estimates that a good program with all the reinforcers in full sway might persuade perhaps a third of the commuters to accept carpooling.

Dodson EN. COST-EFFECTIVENESS IN URBAN TRANSPORTATION. Operations Research. May 1969, v17, n3, pp. 373-394.

A cost-effectiveness study is reported of urban transportation that was conducted as a part of a large systems-analysis effort to investigate present and future modes of transportation within selected cities. The paper gives a comprehensive array of socioeconomic cost and effectiveness measures, and presents summary procedures for the full range of investment and operating costs, social impacts, and special factors affecting the quality of urban living./Author/

Ferreri MG. IMPROVING URBAN BUS OPERATIONS. American Society of Civil Engineers Journal of Transportation Engineering. August 1970, v96, nTe3, Procedure Paper 7465, pp. 319-331.

Most operations now favor long-lived diesel-powered buses over electric trolleys to lower costs and increase routing flexibility. The few vehicle innovations otherwise attempted, such as size variations, anti-air pollution devices, containment of production monopolies, and rider amenities, are limited in meeting the principal financial stress of increasing cost of labor coupled with declining revenue. Fare changes have predictable limits: upward to 25 cents, revenue gains offset passenger losses; higher rates create both revenue and riding losses; and free transit service is deemed unproductive of revenue and ridership benefits. Convenience of service -- increased speed, elimination of the need to transfer, and enhancement of passenger comfort -- remains the most likely, and largely untried, area of urban operations improvements. Possibilities include installation of bus shelters, operation of express buses, and preferential treatment of bus transportation such as

transit streets, exclusive bus lanes, preferential signal timing, bus-actuated traffic signals, and rapid busways./Author/

- *Freeway Airspace*

FREEWAY AIR SPACE EXAMINED. Western Construction. December 1966, v41, n12, p. 66.

Uses of air space over and under freeways are being examined by Real Estate Research Corporation of Los Angeles under a $25,000 contract from the California Transportation Agency. In some parts of the United States, parks, transportation terminals, restaurants, office buildings, and apartment houses have been established in freeway air space. At this time, some space under California freeways is being used for parking facilities with annual rentals of over $400,000 being collected. The California Transportation Agency and the California Division of Highways, in association with several counties and cities, have been compiling data on air space for the past few years. This research contract, the next step in the planning sequence, is expected to be complete by February 1967.

Cook TL. A STUDY OF AIRSPACE UTILIZATION. Real Estate Research Corporation, California Transportation Agency, California Division of Highways. February 1967.

This study examines the nature of air rights, the economic and social impact of using air space, and the administrative problems involved in coordinating the use of air space. The analysis includes examination of existing experience with air space use to determine the extent to which this experience is relevant for California. For example, costs of developing air rights are related to land values to provide some indication as to the feasibility of developing air rights. Costs are typically $15 to $20 per square foot; e.g., $600,000 per acre. In West Coast cities, this occurs only in CBD's of large cities; e.g., in Los Angeles, values range up to $100 per square foot and in San Francisco up to $150 ($6 million per acre). The report also recognizes that air rights may, at times, be used for noneconomic reasons; e.g., prestige. As the author notes, airspace improvements should be aesthetic, but aesthetic to whom? The analysis of impact includes effects on motorists and effects on nonusers. Nonuser effects especially will vary. Use of air rights can minimize undesirable barrier effects of freeways, but may also minimize the associated open space advantages. Profitable and beneficial multiple use can be made of freeway rights-of-way, but the study also calls attention to such matters as financing and coordination problems during extended periods of construction and the problem of obsolete or abandoned structures, because airspace projects typically have shorter lives than highways.

- *Handicapped Patrons*

Levine R. BART AND THE HANDICAPPED. Metropolitan Transportation Commission, Department of Transportation, Department of Housing and Urban Development, University of California at Berkeley. November 1974,

Contract No. DOT-OS-38176, 67 pp.

A 10-year review of BART, with regard to special facilities for the handicapped, shows a gradual awareness of needs as citizen pressure has mounted. Special facilities for the visually and audibly disabled are not yet provided, and many elevators are awkwardly located for the physically handicapped. A study team in 1974 found many minor elevator operational problems, with an additional barrier for wheelchair users, as the lack of level access to and egress from buses that transfer with BART. It is observed that new responsibility is now being taken to provide transportation for the handicapped and that BART has set a planning precedent. NTIS PB 239211/6ST.

TRANSPORTATION FOR SENIORS AND HANDICAPPED PERSONS IN ROCKLAND COUNTY. RRC International, Inc., Urban Mass Transportation Administration. January 1974, Contract No. UMTA-IT-09-0023-74-2, 109 pp.

The objective of the report is to develop a precise description of the transportation problems of the handicapped and elderly in Rockland County, New York and to formulate an operational solution to these problems. The essence of the statement of work scope is that a joint federal-local, multi-agency approach should be used to develop the transportation facilities deemed necessary as a result of this planning study. Key elements to the work statement are data gathering and analysis, system design sketch, support plan, and implementation plan. Some of the major problems facing the elderly and handicapped are delineated. A system design plan incorporating some of the following elements has been developed: establishment of a county office responsible for all transportation activities; development of a "Council of Agencies" to coordinate agency needs, including transportation; appointment of a Policy Advisory Committee drawn from the agencies, government, target group, and employers; "Purchase of Service" agreements between agencies and the centralized transit operation to provide target group activities; and recommendation of federal funding for three major purposes.

Noakes EH. DESIGNING PUBLIC TRANSPORTATION FOR USE BY THE HANDICAPPED. New Concepts in Urban Transportation. October 1972, v2, n8, pp. 240-242.

At any given time, 10 percent of potential users of mass transit systems are permanently or temporarily prevented, by reason of a physical handicap, from using a system designed for the average person. If it is assumed that public transportation investments are made to benefit all the people, the handicapped suffer a loss of equity in addition to their inconvenience. In fact, the "averages" that are used in physical design fit the needs of less than a quarter of the population. One estimate has it that, within a decade, half of the population will be permanently handicapped, living with a chronic disease, or be over the age of 65. Other estimates indicate that there are enough handicapped persons to justify economically the design requirements that would permit them to become transit passengers and sources of operating revenue. Recommendations are made respecting design criteria for stations, rail rapid transit cars, and mass transit buses.